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COMMUNITY HEALTH CENTRES AND HOSPITAL COSTS IN ONTARIO

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Community Health Centres and Hospital Costs in Ontario

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Contents

Abbreviations

ALS	Average length of stay in hospital per discharge and death
BC-BS	Blue Cross–Blue Shield
CHAC	Community Health Association Clinic (Saskatchewan)
CHC	community health centre
CLSC	CHC in Quebec
FEHBP	Federal Employees' Health Benefits Program (United States)
GHA	Sault Ste Marie and District Group Health Association
GHI	Group Health Insurance Plan
GNP	gross national product
GPP	gross provincial product
HIF	Health Information Foundation (United States)
HIP	Health Insurance Plan of Greater New York
HMO	health maintenance organization
ICDA	International Classification of Diseases adapted for use in the United States
IPA	individual practice association
MCF	medical care foundation (one type of HMO)
MCG	Medical Care Group at Washington University
NORC	National Opinion Research Center (United States)
OBC	Ontario Broad Code classification of diagnoses
PGP	prepaid group practice
RHN	Rochester Health Network

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Preface

This project is in a sense the culmination of seven years' interest in hospital cost analysis and in the community health centre concept in Canada. My fascination with the former topic was originally more technical than health-care-related, having been nurtured in a graduate econometrics course. An attempt to replicate the Evans and Walker (1972) analysis of BC hospitals quickly drove home the conceptual and analytic complexities involved in such exercises. During a subsequent reading course in health economics it became apparent that the Evans-Walker methodology had not received widespread testing or application.

That same reading course revealed an area within the literature on community health centres and prepaid group practices (CHC/PGP) that had been left largely untouched by research on health care delivery systems. Much attention had been (and continues to be) devoted to documenting the effect of those alternative delivery organizations on inpatient hospital utilization. But the analyses had generally stopped short of considering the implications of that evidence for both hospital and total health care expenditures. This seemed, in part, due to inadequate disaggregation of hospital cost data. Out of these two seemingly unrelated strands within the health care literature came a thesis that attempted to estimate the financial implications of the CHC/PGP hospital utilization literature.

The present study extends and refines that thesis. It has five main themes: a detailed review and causal analysis of the CHC/PGP hospital utilization literature, which supplements the oft-reviewed American experience with the limited available Canadian evidence; a time-series/cross-section cost analysis of 182 Ontario public general hospitals over the period 1969-74; the use of the cost analysis to obtain marginal cost estimates, per day and per separation, for each of 237 adapted Ontario Broad Code disease classifications; the combining of a subset of the CHC/PGP literature with the derived marginal cost estimates to

estimate gross hospital expenditure savings from CHCs and PGPs; and finally, using these results together with some other studies to assess the likely net financial effect on hospital and health costs of a widespread expansion of community health centres in Ontario.

Cost savings turned out to be less than expected. If a rough figure of 20 per cent lower inpatient utilization by CHC subscribers is accepted, it does not translate directly into a potential 20 per cent reduction in hospital operating costs. Such factors as non-inpatient care activities, application of marginal rather than average costs to the utilization differentials, and the diagnostic mix of the 'saved' inpatient cases all tend to erode the 20 per cent figure. Even then, the resulting hospital cost-saving estimate presumes that freed beds will not be filled again and the saved inpatient cases will require no substitute ambulatory care. If other, less optimistic assumptions are made, the net cost savings shrink further.

Not that the CHC concept is without merit. This research shows that potential hospital cost savings could be obtained through expansion of the CHCs within certain health care financing situations. But the savings will not be in the order of 20 per cent. There may of course be other methods of cost saving within CHCs (e.g. on the medical services side). Opponents of the CHC concept may be tempted to interpret this study as supportive evidence. Unfortunately such an interpretation, based solely on these results, is not sustainable. While hospital cost savings may not be in the order of 20 per cent of gross health budgets, the major cost saving potential of CHCs may be embodied in their ability to utilize a more cost-effective mix of human and physical capital in delivering non-hospital services. Further research is needed here. All potential cost-saving streams must be weighed against the potentially large start-up costs of an expanded CHC program. And other non-pecuniary costs and benefits, such as relative quality of care, access, and the like must be incorporated into any public policy decisions. The evidence here suggests that those other methods and other factors, which have traditionally received less attention than the saving of costs through reduced hospital use, deserve a closer look if the community health centre is to remain a concept whose time may yet come.

Acknowledgments

This study owes a great deal to Robert G. Evans. To students of health care delivery, his methodological contributions will be evident. Much of that results from his role as my thesis supervisor, a role in which his perpetual drive, enthusiasm, and innumerable insights on many occasions prevented the thesis from faltering. The present study, an outgrowth of that thesis, also benefited from his helpful comments at various crucial points.

Because this study is an extension of the thesis, two distinct sets of acknowledgments are necessary. Donald Anderson, Ernst Berndt, Greg Stoddart, Russell Uhler, and Hugh Walker provided timely suggestions and analytic expertise during the thesis development. Keith Wales, Lewis James, and Frank Flynn deserve special thanks for their many hours of assistance with the computing problems that inevitably arise during the manipulation and analysis of such large data sets.

Despite the experience gained during the course of the thesis, this study brought with it a whole new combination of analytical, computer, and data problems. Most of that burden was borne by Dan Markovich and, in the later stages, Glen Siegel. Dan showed particular resilience during the almost two years it took to develop the data base for Ontario and to run the hospital cost model through least squares and maximum likelihood estimation. Glen was a co-sufferer during the debugging of the marginal cost simulation program. I am also indebted to the rest of the staff at the Ontario Economic Council for providing an amicable and stimulating work environment. In particular, Mary Seminsky was always willing to provide secretarial and moral support whenever I required something by yesterday, and Don Dawson, Paul Lonergan, Michael Mendelson, Larry MacDonald, Freya Godard, and Lorie Tarshis assisted administratively and editorially. Eugene Vayda, Pran Manga, and an anonymous

reader offered many improving suggestions, and Annette Stark showed admirable patience in the late stages.

Statistics Canada and the Data Development and Evaluation Branch of the Ontario Ministry of Health kindly provided the data on hospital services, financing and utilization.

Despite the valiant efforts of the persons mentioned here as well as many others who remain unnamed, this project would not have been completed without the moral support, love, and friendship of Rachel Barer.

Tempting as it may be to share the blame for the final product with some or all of the above, I am forced by logic and convention to accept responsibility for any errors that remain.

COMMUNITY HEALTH CENTRES AND HOSPITAL COSTS IN ONTARIO

1

Introduction and background

Unnecessary or inappropriate hospitalization is an issue that has received much attention recently. Patients in acute care facilities, it has been argued, often do not require institutionalization of any kind or could be looked after just as well in extended care or in other institutions.[1] The possibility that health care resources have been misallocated in this way has become particularly important because of the rapid growth in health sector expenditures in Canada and the United States over the past two decades and the central role played by the acute care hospital in the health care delivery systems in those countries.

The organization of primary care is frequently cited as a cause.[2] Much of that care is provided by physicians working out of private practices that charge the patient or a third-party funding agency a fee for each service rendered. For various reasons discussed later, such a system may encourage the use of inpatient hospital facilities, the most expensive segment of the health care delivery system.

One system often advocated as a way of reducing inpatient hospitalization and thus hospital costs is an alternative organization of primary care – the prepaid group practice (PGP) or community health centre (CHC). The prepaid group practice, an American organization, offers a comprehensive mix of specialist and diagnostic facilities in one location, serves an insurance as well as a

1 There are a number of possible ways of defining 'unnecessary' or 'inappropriate' (Pauly 1979). Here we mean that from a social perspective the benefit/cost ratio is higher for non-hospital treatment (or no treatment) than for hospital-based treatment. See Mason et al. (1980) for one example of an attempt to disaggregate hospital use according to necessity of admission.

2 Primary care institutions not only provide services 'at first contact between the patient and health professional, but also [have] responsibility for promotion and maintenance of health and for complete and continuous care for the individual, including referral when required' (Mustard et al., 1974, II). Thus, general practitioners provide primary care services, as do specialist physicians and hospital emergency and inpatient departments when they serve as the initial patient/medical-care-system contacts for an illness episode. Secondary care is provided by hospitals and specialists to whom patients are referred.

delivery role by contracting to provide a specified set of services in exchange for payment of a predetermined fee or premium, and usually pays its member physicians a salary (sometimes augmented by an income-sharing agreement). The community health centre is the Canadian equivalent.[3] It is argued that the convenient availability of diagnostic and therapeutic facilities and the lack of a fee-for-service payment system tend to reduce the incentive to hospitalize. Indeed, the studies of these alternative primary care settings have become a major source of evidence that hospitals are often inappropriately used.

Matched populations of patients receiving primary care either from a PGP (or CHC) or from the more traditional (and more common) private practitioner have exhibited significant and consistent differences in rates of hospital admission and total hospital utilization. Those rates have been repeatedly found to be lower for PGP/CHC patients. Since the populations are more or less 'matched' in terms of age, sex, and other potentially confounding factors, there seems to be either excess hospitalization for patients of private practitioners or insufficient hospitalization of PGP/CHC patients. As we shall see later, excess use seems the more plausible explanation.

Very few attempts have been made to pin down how much inappropriate hospitalization may be costing or what could be saved by alternative methods of primary care. One reason so little is known about costs is that to convert hospital utilization differences into cost differences demands data on the costs of hospital treatment. Potential gross expenditure savings will be equal to the hypothetical hospital costs of treating those CHC/PGP patients who were not hospitalized but would have been had they not received their primary care through the PGP or CHC.

In Canada there is no price information for individual hospital services (which are generally reimbursed by global budgets). Instead of trying to discover what it costs to treat a specific illness in a hospital, one might simply take the average cost per day (total hospital expenditures divided by the number of days of care provided) and multiply it by the hospital days 'saved' in the PGP/CHC setting. The resulting figure for the population enrolled in that setting could be extrapolated to the entire population of the province. The result would be an estimate of potential hospital expenditure savings in a hypothetical setting where all primary care is offered through PGPs and CHCs. Unfortunately, this crude 'back of an envelope' calculation can be misleading. It embodies two obvious and unrealistic assumptions. First, it assumes that every hospital day or admission 'saved' through CHC/PGP primary care delivery costs as much as any

3 Similarities and differences between the PGPs and CHCs are detailed in the following chapter.

other. Yet treatment costs obviously differ greatly by illness. Second, by applying *average* costs it assumes that even if all treatments are the same the added cost of the last patient is equal to the average cost of all previous patients. And yet the fixed costs associated with equipping and staffing a hospital represent a significant share of the total; once they have been met a few extra patients can be accommodated less expensively.

Simple calculations will not compensate for the inadequacy of our data. The first task is thus to estimate in some way the cost of treatment for each diagnosis in a hospital. More accurately, it will be the *marginal* cost, that is, how much will be saved by treating one patient fewer for each disease or medical condition. This rather complex procedure occupies Chapters 3 to 5 below. It occurs in two stages. The first stage specifies a model of the relationships between hospital-specific average costs and various hospital-specific characteristics (activity mix, occupancy rate, and mix of patients, for example). Using statistical techniques described in Chapter 4, we establish the importance of each of these characteristics in explaining differences between hospitals in average costs. We then have an estimate of the relative importance of patient mix, occupancy rate, number of beds, and so on in explaining why one hospital has higher or lower average costs than another. One of these variables, of course, is patient mix. Therefore, by holding all other variables constant, we can see how much cost difference is represented by treating different mixes of diagnoses.

The second stage of the analysis (Chapter 5) attempts to answer a series of disease-specific questions of the following type: if hospital X had treated Y fewer patients with diagnosis Z in any given year, what would have been the effect on that hospital's average costs? The case mix of hospital X therefore changes, entailing slight changes in the values of some of the explanatory variables in the model; making those changes allows the estimation of a new average cost associated with the new hypothetical case mix. An arithmetic comparison of the 'old' and 'new' average costs yields marginal costs for diagnosis Z in hospital X. This procedure is repeated for each diagnosis and hospital, and results are aggregated across hospitals to generate estimated provincial diagnosis-specific marginal costs of inpatient hospital care.

We next compare two hypothetical situations in Ontario: in one there are no CHCs, only private practitioners; in the other there are no private practitioners – the point of entry for primary care is the CHC. In Chapter 6 the utilization differences and the marginal costs estimated in Chapter 5 are used to estimate the difference between these two situations in hospital costs.

What are we to conclude? First, a 20 per cent reduction in hospital admissions or days' stay does not, even under the best circumstances, translate into a 20 per cent reduction in provincial health care expenditures. Although hospitals are the

largest single component of the health care sector, they still account for less than 50 per cent of total expenditures for this sector.

Furthermore, a reduction of 20 per cent in hospital inpatient utilization does not even imply anywhere near equivalent *hospital* expenditure savings. Hospitals are involved in activities other than inpatient care, and it is often the less complex and thus less costly inpatient conditions that avoid hospitalization through the use of the PGP or CHC. In addition, marginal costs are shown to be lower than average costs. Since the simple proliferation of CHCs is unlikely to eliminate hospitals, it is marginal costs in which we are interested.

To the extent that 'saved' hospital cases still require some ambulatory care, the 20 per cent figure will be further eroded. And finally, if CHC/ PGPs are able to keep patients out of hospitals but other patients fill the beds made available, cost savings (if any) shrink further.

Wider use of CHCs is thus not likely to reduce health costs appreciably through diminished inpatient hospitalization. But that does not mean the concept should be shelved, in Ontario or anywhere else; at least such a conclusion *cannot* be drawn from the evidence produced here. There seems, however, to have been undue emphasis on the ability of CHCs to save hospital costs. This has minimized informed discussion and research on other ways in which they could reduce health care expenditures or improve the non-monetary aspects of health care delivery.[4]

BACKGROUND

In 1978, hospital expenditures accounted for 45.4 per cent of all health care expenditures in Canada and for 3.2 per cent of our gross national product (GNP). Not surprisingly the corresponding figures for Ontario's hospital care were quite similar – 42.9 per cent of provincial health care costs and 2.9 per cent of the gross provincial product (GPP). Accordingly much of the research into the attempts to control costs in the health care delivery sector has concentrated on hospitals. But absolute expenditure levels are rarely sufficient justification for a major research effort, and the hospital sector is no exception. The extraordinary growth of the sector over the last few decades has attracted increasing concern and interest. The nominal dollar increase in provincial hospital expenditures in the sixteen years from 1960 to 1978 was more than 750 per cent, an average

4 This is not to belittle the serious health-related concern of unnecessary hospitalization. There is growing evidence that hospitals are themselves a significant health hazard, and certainly no place for people who have alternatives. Unfortunately this aspect of this issue has received relatively little attention in the public policy forum and in the segment of health services literature dealing with PGPs and CHCs.

yearly increase of 12.7 per cent during a period in which GPP grew an average of 10.6 per cent per year (Table 1). The result had been, until recently, a relatively steady increase in the share of GPP absorbed by the hospital sector (Table 2). In fact, while the health care sector as a whole has retreated from its 1971 high in terms of share of GNP, the hospital sector hit new highs as recently as 1975. The drop in health care expenditures as a proportion of GNP has been achieved largely without the 'assistance' of the hospital sector.[5]

Not only has the hospital sector outgrown Ontario's GPP and Canada's GNP, but it has also been the fastest-growing component of the health care sector itself.[6] In short, it is not so much the absolute expenditure level that has caused concern (because what that level should be is disputable) as the rapid growth of expenditures in the midst of doubt about their marginal benefits.

Of course from Table 2 one could argue that Canada is better off in terms of expenditure growth than the United States, where the ratio of health expenditure to GNP surpassed ours in 1970 and as yet shows no signs of slowing down. But the issue is really whether Canada and Ontario are satisfied with what they are receiving from that significant part of their gross expenditures that is devoted to health care. Lingering in the background also is the fear that even the relative stability of 1971-8 may be difficult to maintain. As the Ontario Economic Council (1979) pointed out in a recent policy paper, a number of factors are already hindering efforts at restraint or may do so in the future in the largely labour-intensive health services sector:

- elimination of wage and price controls;
- physician unrest over recent small nominal (and negative real) increases in fee schedules (ibid., 25);

5 In fact, physician services absorbed a good deal of the slowdown: expenditures on these services constituted 1.33 per cent of Ontario's GPP in 1971, fell to 1.09 per cent in 1974, and remained at that level as recently as 1978. One need not be overly concerned about those physicians' welfare, however. While hospital expenditures in nominal terms grew by 283 per cent in the period 1960-71, aggregate physician services expenditures almost kept pace at 260 per cent, a yearly rate of increase of 12.3 per cent. In addition, as Barer et al. (1979) point out, in 1960 the net annual receipts of Canadian physicians were 4.15 times greater than an annualized industrial composite average weekly wage. That figure grew steadily to a peak of 5.70 in 1971 and has declined just as steadily since then. But in 1975 physicians were still ahead of their relative position in 1963.

6 Provincial expenditure data from Canada (1979a, 1980a) permit calculation of the following Canadian average yearly expenditure growth rates for 1960-78: hospital services 12.8 per cent, physician services 11.5 per cent, dentist services 12.5 per cent, drugs and appliances 10.3 per cent. Total health care sector expenditures excluding hospitals grew 11.1 per cent annually and including hospitals 11.9 per cent.

TABLE 1

Selected health care expenditure statistics, Canada and Ontario, 1960-78

	Ontario			Canada		
Year	Hospital expenditures ($000)	Physician services expenditures ($000)	GPP GPP ($million)	Hospital expenditures ($000)	Physician services expenditures ($000)	GNP GPP ($million)
1960	306,903	142,010	14,638	834,932	355,014	38,359
61	343,621	154,813	15,360	930,568	388,305	39,646
62	381,729	161,701	16,335	1,031,749	406,075	42,927
63	421,995	182,704	17,795	1,150,306	453,395	45,978
64	463,671	203,488	19,543	1,273,380	495,657	50,280
1965	515,994	225,669	21,661	1,434,274	545,056	53,364
66	573,922	247,925	24,473	1,637,647	605,200	61,828
67	681,730	286,618	26,336	1,880,699	686,189	66,409
68	803,534	331,587	29,215	2,179,906	788,089	72,586
69	906,817	378,872	32,638	2,456,687	901,435	79,815
1970	1,026,063	448,580	35,314	2,758,581	1,040,739	85,685
71	1,168,178	510,559	38,391	3,078,509	1,250,413	94,450
72	1,286,633	550,382	43,272	3,365,212	1,386,199	105,234
73	1,414,510	579,615	50,088	3,783,246	1,483,421	123,560
74	1,714,155	650,620	59,615	4,588,432	1,659,651	147,528
1975	2,094,323	752,196	65,309	5,679,042	1,914,089	165,343
76	2,341,600	811,836	74,178	6,434,600	2,103,200	191,166
77	2,473,600	890,100	82,052	6,768,500	2,309,000	209,379
78	2,628,100	983,200	89,736	7,337,700	2,539,100	230,407

SOURCE: Expenditures: Canada (1979, 1980), and personal communication; Ontario GPP from Ontario (n.d. 1971, 1979) and personal communication; Canadian GNP from Canada (1970-80)

TABLE 2

Hospital expenditures as a share of gross national product and gross provincial product, Canada and Ontario, 1960-78

	Ontario hospital expenditures as a percentage of GPP	Canadian hospital expenditures as a percentage of GNP	Total Canadian health care expenditures as a percentage of GNP	Total health expenditures for the United States as a percentage of GNP
1960	2.10	2.18	5.62	5.3
61	2.24	2.35	5.92	5.5
62	2.34	2.40	5.90	5.6
63	2.37	2.50	6.02	5.7
64	2.37	2.53	6.00	5.9
1965	2.38	2.59	6.07	6.2
66	2.35	2.65	6.10	6.3
67	2.59	2.83	6.39	6.6
68	2.75	3.00	6.63	6.8
69	2.78	3.08	6.76	7.1
1970	2.91	3.22	7.10	7.6
71	3.04	3.26	7.34	7.8
72	2.97	3.20	7.17	7.9
73	2.82	3.06	6.82	7.8
74	2.88	3.11	6.71	8.2
1975	3.21	3.43	7.19	8.6
76	3.16	3.37	7.09	8.8
77	3.01	3.24	7.04	9.0
78	2.93	3.19	7.04	9.1

SOURCE: Columns 1, 2 and 3: Table 1; Column 4: Canada (1973) and Gibson (1979)

- changes in Canadian demography, which will see large increases in the proportion of old people in the population over the next four or five decades (Gross and Schwenger 1981).

Neither the expenditure levels and growth patterns to date nor the suggestion that those levels may rise again in future would be cause for concern if it could be clearly demonstrated that the continuous expansion in the hospital sector was leading to a healthier Ontario, and more important, that those incremental health benefits justified the costs. In other words, if additions to hospital expenditures could be shown to be the cost-effective choice when compared with other possible uses for those funds, there would be little public or private concern over the growth of hospital expenditures. The sheer volume of research on expenditure trends and components, decision-making within this sector, and the cost effectiveness of numerous alternative treatment regimens and settings suggests that concern is warranted.

In fact, students of the health care system are becoming more and more convinced that the present levels of health status can be maintained at lower resource cost. It follows that if the pursuit of improved health status is deemed a worthwhile social objective, it should be at least partially attainable with current expenditure levels. The federal government's White Paper (Lalonde 1974), for example, stated that the contribution of the present health care system to the health of the population now seemed small at the margin. Cochrane (1972), Illich (1975), and McKeown (1976) are among those who have presented evidence that many medical procedures are either unnecessarily costly in relation to their effect on health status, or inefficacious (that is, they have not been proved superior to no treatment at all). While there has been a growing undercurrent of support for more emphasis by the medical profession on prevention and less on cure, Morgan (1977) suggests that the profession is very limited in its ability to prevent illness.

In almost any other industry, expenditure increases of the size discussed here would bring joy to the hearts of shareholders and managers alike. Increases in output and productivity would be welcomed and encouraged. In fact, the same might be said of medical care if one were using an appropriate measure of output. Certainly no health economist would dispute the desirability of increased productivity in this sector. However, the evidence noted above suggests that more hospital cases, or days, or office visits (the common output proxies) are not unequivocally better than fewer. In fact it has been suggested that the marginal social utility of such output is often small and perhaps even negative. In short, the possibility that significant amounts of unnecessary care are consumed cannot be dismissed out of hand. Increased output (if measured in

terms of service consumption) should not necessarily be a goal of public planning.

Advocates of a consumer sovereignty model would argue that patients who increase their consumption of hospital services are doing so because the consumption of additional units of care at the margin provides sufficient utility. The counter-argument, apparently more satisfactory in view of the fact that in Canada medical care is 'purchased' privately but funded largely from the public purse, is based upon an implicit model in which health status and medical services are both arguments in the consumer's utility (preference) function. In this model the marginal effect on a consumer's utility of the receipt of medical care will consist of two parts. Not only will there be some impact on utility deriving from the actual 'consumption' of the medical services, but to this must be added the indirect effect of that consumption on health status, which in turn affects utility.[7]

The reason for making contact with the medical care delivery sector is presumably a belief (on the part of the prospective patient) that as a result of that contact (and any subsequent contacts within the same 'episode of illness') he or she will be made better off. Assuming that increased health status leads to increased utility, and that the consumption of medical services (actual receipt of treatment) is itself an unpleasant (utility-reducing) activity, the total effect of receiving care on utility depends on the qualitative and quantitative effect of medical services on health status.[8]

In the conventional utility-maximizing model, fully informed consumers buy additional units of medical care so long as that activity's ratio of marginal utility to price is greater than the equivalent ratio for all other goods and services. But the full-information assumption built into that model implies that the consumer-patient knows what the total effect of his consumption decision will be on his utility. Here it is suggested on the other hand that the consumer believes his decision will increase his utility because he expects the effect of medical services on health status to be sufficiently positive. An overestimate, by patient or provider, of the effect of care on health status may lead to the consumption of medical goods and services that would not have been bought in a market

7 Denoting health status and medical services by HS and MS, and the consumer's utility function by $U = U(\text{HS}, \text{MS}, \ldots)$, where $\text{HS} = \text{HS}(\text{MS}, \ldots)$, the marginal impact will be given by $dU/d\text{MS} = \partial U/\partial\text{HS} \cdot \partial\text{HS}/\partial\text{MS} + \partial U/\partial\text{MS}$.

8 The assumptions that $\partial U/\partial\text{HS} > 0$ and $\partial U/\partial\text{MS} < 0$ still leave $dU/d\text{MS}$ unsigned in the absence of information about $\partial\text{HS}/\partial\text{MS}$. Note that this parameter is unrelated to the individual consumer's utility considerations – it is simply a technical, production-process-determined term that the prospective consumer believes to be sufficiently positive to yield the expected $dU/d\text{MS} > 0$.

characterized by perfect information. Note that, while the consumer's utility considerations initially determine entry into the system, the provider's valuation of expected health status impact may prompt further 'purchases.'

At this point, two effects should be distinguished. First, not only is this 'market' characterized by ignorance and uncertainty on the part of the consumer and by an information gap between consumer and supplier, but its functioning is further hindered by lack of product knowledge on the part of the supplier. In particular, the physician may be unable to determine (with any certainty) the effect of a prescribed set of procedures on a patient's long-run or short-run health status. It is the consumer-provider information gap that giyes rise to the so-called physician-patient agency relationship in which the consumer relies to a great extent on the physician for guidance. But it is the combination of consumer and provider uncertainty, with the divergence that may result between the expected and actual impact of medical service consumption on patient utility that may lead to excess (or unnecessary) utilization.[9]

Second, it is the actual (and hence often unknown, at least in the short run) effect of medical services on health status that might be considered a proxy for the effect upon social welfare of additional medical care industry 'output.' But in addition to legitimate overestimates of this effect by provider and patient, unnecessary utilization may also derive from the supplier's conflict of interest.[10] For the supplier of care, increases in utilization (to the extent that they do not

9 If expected is greater than actual, unnecessary utilization is occurring, as described below. This is more likely than the reverse. If actual was in aggregate greater than expected, we would observe neither evidence of excess utilization nor such rampant increases in the utilization of health services with very little resulting effect on health status. The sovereign consumer who plays the lead role in that utility theory of demand loses a significant amount of his sovereignty when we introduce the supplier-influenced agency relationship, and as Culyer (1973) points out, there are some clear-cut cases (mentally ill patients, emergencies) where consumer sovereignty is a sham. It is interesting to consider other, seemingly analogous, consumer-supplier interactions. If we think of the purchase of medical care as an attempt to upgrade health status, one immediate analogy that comes to mind is the repair of a 'sick' automobile. Again, the consumer often knows little about the quality of the producer (the mechanic) and is generally incompetent to judge the effect of the production process on the car's long-term 'health status' (except in severe cases where there is an obvious improvement, or in cases of clear neglect in which the car's post-care operation is worse than before). Thus, both the information gap and the consumer-supplier agency relationship exist. However, there is likely to be more 'shopping around' in this market: prices play a rationing role and are often advertised, the supplier is usually aware of the effect of the prescribed treatment on the condition of the car, and the ailments are not life-threatening (unless for example a brake line springs a leak or a steering column or axle suffers a severe fracture). A closer approximation to the health care situation is provided by the interaction of a university faculty with graduate students. Supplier influence on course of 'treatment' is prevalent. There may be consumer and supplier uncertainty about

conflict with other parameters in his or her utility function) are desirable because they increase net income (or practice revenue), an important parameter in the utility function. Thus, the possibility of conflict between social utility and supplier utility emerges and is further enhanced by the uncertainty (on the part of both consumer and provider) that affects production decisions.

This illustrates clearly the pervasiveness of uncertainty in the determination of utilization levels. In particular, lack of information may lead to 'consumer abuse' as manifested through (for example) numerous consultations or dissatisfaction with an office visit that does not provide some concrete 'cure' such as a prescription. Lack of information may also give rise to the two distinct provider-motivated excess 'demand' channels noted above.[11]

Within the hospital sector the research emphasis has been more on the 'unnecessarily costly' than on the 'inefficacious' aspects of inappropriate resource utilization. Since hospitals are the most resource-intensive places of treatment in the health care delivery system, wrongly placed patients lead directly to fairly substantial social welfare losses. Inappropriate hospital utilization may take on many guises. In a hospital with low occupancy, patients may be encouraged to stay longer (at minimal or no direct cost to the patient in Canada). Admission for conditions amenable to outpatient treatment, but

the long-run effect of additional consumption of courses on the student's human capital stock. The consumer often relies rather heavily on the supplier for advice about the most appropriate mode of treatment for the 'insufficient education' condition. In this market, however, there may be advertising (recruiting of students), and the analogy to the emergency case never appears; one also suspects that the effect of additional education consumption is far less uncertain than that of medical care consumption. The most important distinction is the lack of life-threatening situations. It would appear, then, that the assumptions underlying the consumer-sovereignty utility-maximizing model are more severely violated in the case of health care consumption than in either of the above situations.

10 This phenomenon is not peculiar to medical care consumption. A similar conflict of interest confronts the automobile mechanic (*Toronto Star*, 30 October 1976, A1, A14). The educator, to the extent that student numbers secure his or her position, may be similarly influenced. If there is any characteristic that sets medical care providers apart with respect to conflict of interest, it is that an over-zealous adherence to the financial side of the dichotomy may endanger the consumer's life. Society's judgement as to the relative values of good health, good education, and a finely tuned car ultimately determines the severity of the respective conflicts of interest.

11 The 'conflict-of-objectives' may appear as 'revolving-door' medicine, while physician uncertainty seems particularly acute in prescribing drugs. Silverman and Lee (1974, 2) state that 'adverse drug reactions – due in large part to well-intentioned but irrational prescribing – are now responsible for a million or more hospital admissions annually in the U.S. alone, tens of millions of days of prolonged hospitalization, thousands of preventable deaths, and the resultant expenditure of billions of dollars each year.'

handled more conveniently and profitably through inpatient care, may be encouraged.[12] Finally, physicians may hospitalize their patients and use hospital facilities for diagnostic purposes where laboratory and radiology 'work-up' could be done elsewhere.

If indeed there is evidence that unnecessary hospitalization does occur, the implication is that the patients affected would derive at least equal health-status-related utility from different (or no) treatment. But that is, of course, only half of what is essentially a cost-effectiveness issue. A debate still rages in the health services literature over how the aggregate costs of alternative combinations of treatment settings compare. The persistence of the debate is not surprising, given the shortage of relevant data on comparative costs. This study attempts to fill part of that information gap.

A READER'S GUIDE TO THE STUDY

Chapter 2 reviews the evidence suggesting that prepaid group practices and community health centres can significantly reduce inpatient hospitalization. The behavioural analysis in the latter part of that chapter suggests that these data do not reflect isolated phenomena – the differentials could be expected to persist if new PGP/CHCs were to be established, provided they functioned in payment/insurance settings equivalent to those existing at the time of the utilization studies. In addition, the utilization data that are linked in Chapter 6 with the cost data derived in this project are reported and reviewed.

The diagnosis-specific marginal cost estimates are obtained from a simulation model composed of two estimated hospital cost equations. Chapter 3 articulates the hospital cost model, describes the construction of the variables, and gives the sources of the data. A brief look at some provincial trends and variable correlations forms the transition to estimation of the cost model in Chapter 4. Chapter 5 describes the various stages of the simulation process and reports the marginal cost results, while Chapter 6 links these results to the utilization differential data of Chapter 2. Finally, in Chapter 7 results are summarized and qualified, policy implications considered and some suggestions for future applications and refinements offered.

A summary of the methodology detailed in Chapters 3 through 5 appears immediately before Chapter 3. Readers not interested in the details of the cost estimation process may use this summary as a transition from Chapter 2 to Chapter 6.

12 See the recent evidence provided by Evans and Robinson (1973) and Evans et al. (1978) on day-care surgery, for example.

2

The organization of medical care delivery and its impact on hospital utilization

A comprehensive cost-effectiveness analysis of acute hospital care remains problematic because of a lack of operational health status indices and a means of differentiating hospital influences from other influences on a patient's health. Therefore we must look elsewhere for help in assessing the desirability of the current aggregate levels of hospital expenditure.

As suggested in Chapter 1, a 'natural experiment' way of considering the efficacy of hospital care would be to compare the hospital utilization experiences of patients receiving primary care from different delivery organizations.[1] For such comparisons to be valid, of course, the populations would have to be perfectly matched in terms of prior health status, socioeconomic and demographic characteristics, and all other factors that could conceivably have a differential effect on hospital utilization. In addition, the mix, incidence, and causes of illnesses in the two populations during the period of comparison would have to be identical. Unfortunately, even that tortuous matching of requirements would result in limited useful information. The two populations might turn out to use identical amounts of hospital care. That would answer one question about the differential impact of primary care sources on hospital utilization but would tell us nothing about the 'right' levels of hospital care or about any varying quality of care. In fact, different hospital utilization rates for the two populations would still suggest only that the difference in the two rates may represent 'unnecessary' hospitalization. Without much more information about health status and the effect of hospital treatment, the suitability of the lower level of utilization could not be assessed.

1 The distinction between primary and secondary care was outlined in the previous chapter. Primary sources of care are generally 'first contact' points between a patient and the medical care delivery system. Thus a general practitioner would be regarded as a primary provider, while inpatient hospital facilities are considered in this context as secondary sources of care.

While such experiments are unfortunately confined to the laboratory and randomized trials, many studies have undertaken this type of matched population comparison. Some of their more pervasive methodological problems are outlined by Wolinsky (1980). As noted in the previous chapter, the vast majority of the results suggest that a significant segment of the inpatient hospital utilization in the United States and Canada, while not necessarily inefficacious, may at least be inappropriate.

The present chapter reviews a selection of this literature and considers the possible explanations for the patterns of differential utilization. No study is blessed with perfectly matched populations. Only if all patient characteristics capable of contributing to the observed utilization differences are systematically eliminated, can those differences be interpreted as evidence of unnecessary hospital utilization. Particular attention is given to the limited Ontario data.

While the literature concentrates on comparing the utilization experiences of the solo private practice and the prepaid group practice, those are really only the two extremes in the spectrum of current organizations. The next section explains the choice of these two modes of delivery for comparison.

THE ORGANIZATIONAL SPECTRUM

There are many different kinds of primary practices in Canada and the United States. Although similar in function, they differ in their resources, their physical settings, the means by which they finance themselves, and their methods of remuneration. Of particular importance are the intrinsic differences between American and Canadian institutions,[2] since much of the literature on which this research draws in order to formulate policy directions for Canada is American.

The different categories of delivery systems are not watertight. The distinguishing features of two similar institutions are often ill-defined or imprecise. Here the number or mix of physicians will be used to place an organization in the spectrum. Thus, at one end we observe the single-physician practice; at the other, a multi-functional, multi-specialty group practice or clinic.

In Canada, single-physician practices are still the most common form.[3] In general, these practices are reimbursed (either directly or, in Canada, primarily

2 Roemer (1965) describes the primary care choices available to the American patient, and this section borrows extensively from his framework.

3 In Ontario, for example, recent Ministry of Health data showed that just over one-half of the province's physicians were classified as solo practitioners. This figure undoubtedly underestimates the number actually practicing in this manner, as the remainder includes those physicians with any type of group or clinic affiliation.

through a third party) on a fee-for-service basis. In Canada, fees for various procedures are determined by negotiations between the provincial governments and the medical associations. Thus, one may think of the physician not only as the primary labour input within the practice who collects a salary based on an imputed wage rate, but also as an entrepreneur who receives any residual income or profit deriving from the practice.[4] In Canada, the solo specialist often depends mainly on referrals from general practitioners and fellow specialists for his clientele.

While the distinction between solo practice and all other kinds of practice is defined unambiguously by the number of physicians in the practice, the group/non-group practice distinction is not as clear-cut. 'Group practice' usually refers to any practice consisting of three or more physicians. Between the extremes of solo and group practices, then, is the partnership, and in less well-defined positions on the spectrum are 'medical arts' buildings and hospital outpatient and emergency departments.[5]

One might think of the partnership as the fundamental form of group practice, although this is not common usage. Partnerships often consist of two physicians with a common specialty who provide their services to a single legal practice entity, thereby sharing all expenses, revenues, and 'profits.' Two separate practices in a 'partnership' may instead share some expenses (such as the cost of a receptionist and the rental of office space) while maintaining independent revenue and legal status.

A natural extension of the common-specialty partnership is the single-specialty group in which three or more physicians of the same specialty share facilities, supplies, and ancillary services. Group revenues are obtained from fee-for-service billing. Each physician's income may be a direct function of his volume of billings or determined through an income-sharing scheme. Although income sharing is not necessarily a characteristic of such practices, 'waiting

4 The distinction between the labour input and entrepreneurial roles of the physician is crucial throughout the discussion of this chapter. Evans (1975b) elaborates on the dental analogy.

5 The 'medical arts' building is a physical rather than a financial, legal, or organizational practice entity. It is a means of housing many different kinds of single or group practices in a central location, and it commonly includes one or more radiology and laboratory practices and a pharmacy. Hospital emergency departments, while not forms of medical practice in the sense being considered here, are nevertheless important sources of primary care. Similarly, many hospitals have formal outpatient departments that tend to the less urgent needs of ambulatory patients. Both these types of departments are usually staffed by some combination of interns, residents, salaried employees of the hospitals, and private practitioners who provide services in return for admitting privileges or who practise as full-time emergency specialists on a fee-for-service basis.

rooms, receptionists, telephone service, laboratory, record rooms, and business services are frequently shared' (Roemer 1965, 1155).

Group practice is most commonly regarded as a multi-specialty practice in which three or more physicians use a single location and share their expenses. The group, as a practice, is paid on a fee-for-service basis, while member physicians arrange an income-sharing scheme. The group may vary in size from three or four physicians, who might use a common list of non-group specialists for referral purposes and who send diagnostic work outside the group, to what is known as a comprehensive group. The latter still charges patients a fee for services but now often includes the facilities and personnel enabling it to provide a much broader range of specialties and services, commonly including laboratory and radiological diagnostic services. Members of the group may engage in teaching or research and, whereas smaller groups may in certain cases have some part-time members, the comprehensive groups generally consist of full-time general practitioners, specialists, and paramedical personnel.

At the multi-specialty end of the spectrum we find comprehensive prepaid group practices and community health centres.[6] Although the two are not identical, they are similar: the main difference results from the fact that PGPs are found in the United States and CHCs in Canada. Again, a comprehensive and varied range of facilities and services is offered to the patient in a single setting. In the prepaid practice, a specified population pays in advance of illness for guaranteed access to medical care. Thus, rather than having patients pay for treatment when they receive it, the prepaid group pools the medical risks by requiring each member to prepay for all 'covered' services during a stipulated period (usually one year). In this way, such organizations combine an insurance function with the availability of a large number of 'benefits' to the subscribers. The group itself may be thought of as the entrepreneur (paid by capitation)[7] and thus the claimant of residual profits, while member physicians may be reimbursed by salary or some other non-fee-for-service arrangement.

An important distinguishing feature of the Canadian community health centre is that there is no need for patients either to pay a fee for services or to prepay for such services. Universal health insurance, which reimburses provider

6 The community health centre is visualized ideally as 'a facility, or intimately linked group of facilities, enabling individuals and families to obtain initial and continuing health care of high quality. Such care must be provided in an acceptable manner through a team of health professionals and other personnel working in an accessible and well-managed setting' (Hastings et al. 1973, 1). Physicians are paid in a variety of ways. For a more detailed discussion of the concept, see ibid., 1-11.

7 This refers to payment by the patient of a fixed prearranged sum in return for which he or she is 'covered' for all care provided by the group and included as an 'insured benefit.'

practices on behalf of the patients, precludes any financial responsibility by the patient other than payment of yearly premiums in some provinces and various relatively small direct charges.[8] Thus, the main difference between community health centres and prepaid group practices is that the former either bill a third party (the provincial government) for all medical expenses incurred by the subscribers or are paid by the third party on a capitation or global budgeting basis. Again, the member physicians are paid by salary or pre-arranged income sharing. When considering utilization data from community health centres, however, one must keep in mind that unlike the comprehensive prepaid group practices in the United States there is no financial constraint binding a subscribing patient to the centre. Regardless of the source of care, the patient is not financially at risk. Thus, utilization data may not represent total utilization of medical care facilities by the patients of the community health centre unless care received outside the clinic is allocated back to the clinic. The problem this poses for the survival of CHCs in Canada is discussed in a later section. In the United States on the other hand, patients seeking care outside their PGP must bear the financial consequences, a disincentive that suggests a lesser bias in the data on American prepaid group practices.

Before leaving this discussion of organizational variants, one final label is introduced – the Health Maintenance Organization (HMO). This is a concept or program, more than a single organizational entity, of growing popularity in the United States. Its most common but not its only form is the PGP. Its *sine qua non* is prepayment but, whereas physicians of a PGP are paid on a non-fee-for-service basis, this is not the rule for all HMOs. An HMO 'assumes a contractual responsibility to provide or ensure the delivery of a stated range of health services, including at least physician and hospital services, ... services an enrolled, defined population ... has voluntary enrollment of subscribers ... requires a fixed periodic payment to the organization that is independent of use of services ... [and] assumes at least part of the financial risk and/or gain in the provision of services' (Luft 1980a, 503).

The three major types of HMOs are PGPs, Medical Care Foundations (MCF) or Individual Practice Associations (IPA), and 'networks.' The distinctions among the three are important since their inclusion under the HMO label makes it incorrect to extend the close similarity of CHCs and PGPs to CHCs and HMOs in

8 Patients still pay for some uninsured services such as cosmetic surgery and physical examinations for certification purposes. Current direct charges include, for example, extra-billing by opted-out physicians in Ontario (Wolfson and Tuohy 1980). For a summary of Canada's experience with direct charges, see Beck and Horne (1978). An assessment of the past and future role of such charges is contained in Barer, Evans and Stoddart (1979).

general. While in a PGP 'there is only one insuring agency, the physicians are either salaried or share the income of the group partnership, and the hospitals are at times ... owned and managed by the plan' the MCF 'approach is more varied, typically involving many insurance companies, physicians compensated by fee-for-service and independent hospitals. The foundation is considered an HMO however for it undertakes to monitor the utilization and charges of the individual physicians and guarantees to third-party payers that annual per capita costs will not exceed a specified amount' (Fuchs 1974, 138). Thus, while subscribers prepay to the foundation, it in turn reimburses a loose collection of practitioners on a fee-for-service basis. The foundation itself is not then a form of primary care practice but rather an intermediary between a group of patients and a group of providers. The only characteristic that distinguishes an MCF from any group of private practices is that 'because the foundation itself is prepaid, it needs to control costs and attempts to do so through extensive use of local audit and peer review' (Holahan 1977, 352).

Similarly, the IPA, commonly sponsored by a medical society, 'contracts with physicians to deliver services from their individual office practices. Physicians are usually paid on a fee-for-service basis, but some form of peer review exists. The physicians and the plan generally bear the risk for outpatient services and may, with or without an insurance company, bear the risk of inpatient services' (Goldberg and Greenberg 1979, 1021). United States (1980) provides a detailed history and description of one IPA.

Finally, the network 'consists of numerous independent medical care delivery points organized through a single entity of accountability. In most cases the delivery points are on risk, but the extent of risk ... depends on the individual plan' (ibid.). Within these three categories of HMO are, of course, a number of variations (Wolinsky 1980).

With this range of medical care facilities in mind, we turn to an examination of that portion of the hospital utilization literature that compares utilization experiences of patients receiving care from PGPs or CHCs on the one hand, and fee-for-service practices on the other. Between many types of organizations there is no reason in principle to expect utilization differences. The solo vs PGP/CHC comparison is prompted by the fact that the two modes of delivery differ in so many respects and because the PGP/CHC model has been the subject of so much attention relating to its potential to reduce hospital use. If the reported utilization differences can be shown to be motivated primarily by disparate incentive structures, the chances of making a type I error[9] (in concluding that a significant mount of hospital utilization is inappropriate) are minimized.

9 The type I error in this case would be to reject the null hypothesis that there is no unnecessary or inappropriate hospital utilization, when in fact there is none.

HOSPITAL UTILIZATION EXPERIENCE–A SELECTIVE COMPARISON

The previous section suggested that if certain matching and quality of care requirements were satisfied the differences between the hospital utilization of PGP or CHC subscribers and that of the patients of private practitioners could serve as estimates of the extent of inappropriate hospitalization eliminated by the former primary care settings. This section presents a selective review of the literature that compares those utilization experiences. While lengthy, it is not an exhaustive review; nor is it the first of its kind. Donabedian (1965, 1969), Klarman (1963), and more recently Roemer and Shonick (1973) have all done comprehensive reviews. Shorter reviews abound (see, for example, Frech and Ginsburg (1978), Luft (1978a), Hetherington et al. (1975), and Wolinsky (1980). In light of the abundance of utilization summaries, this section has more limited objectives. First, the behavioural and organizational differences between the populations in the utilization studies are emphasized. Second, the review in this and the section immediately following integrates the Canadian experience with CHCs more extensively than any of the above-noted sources. Finally, an attempt is made to incorporate studies published since the comprehensive reviews noted above.[10]

Most of these hospital utilization studies have compared PGPs with other delivery organizations in the United States. That is undoubtedly a result of the relative numbers of PGPs and CHCs and of the relative numbers of health care researchers in the United States and Canada. However, because of the different insurance systems, caution must be exercised in extrapolating American results to hypothetical Canadian situations. Furthermore, comparisons between different studies of data on admissions, discharges, or average lengths of stay tend to be unenlightening because of methodological, geographical, benefit coverage, and/or other differences embodied in the analyses. The primary concern, therefore, will be with the comparisons within each study.

One of the earliest sources of comparative hospital utilization rates was United States (1952). That study compared the admission rates of three prepaid group practices with the rates for subscribers to Blue Cross plans. While the PGP rates ranged from 70 to 104 admissions per 1000 population, Blue Cross subscribers were admitted 122 times for each 1000 person-years. When average length of stay (hereafter ALS) differences were incorporated, total patient days per 1000 population showed marked differences – 490 to 685 for the PGPs, 888

10 Reviews of the literature, like fashions, tend to be out of date immediately. But they can still provide useful summaries. In the discussion that follows, secondary sources are noted where applicable.

for Blue Cross.[11] These comparisons can be little more than suggestive, however, since the PGPs and Blue Cross subscribers were from various parts of the United States and no standardization (such as age/sex sample composition) was incorporated in the comparisons.

Five studies appearing in the late 1950s and early 1960s compared hospitalization experiences of enrollees in the Health Insurance Plan of Greater New York (HIP)[12] with various other segments of a geographically matched population. The first (Committee 1957), based on a 1951 household survey, compared hospital utilization by members of HIP (who were insured for ambulatory and inpatient care) with utilization by a representative sample of New York City households (approximately one-half of whom had no medical insurance at all). The study reported a higher admission rate for HIP subscribers (81 per 1000) than for the New York City sample (74 per 1000).[13] However, these figures are invalidated by the fact that comparable figures obtained from actual hospital admission records reversed the ranking and suggested a significantly higher admission rate (105 per 1000) for the non-HIP New York City population (Klarman 1963). Furthermore, the same survey also showed that the insured segment of the New York City sample had lower admission rates than the uninsured!

The second HIP study (Densen et al. 1958) used 1955 non-survey data to compare HIP subscribers with a New York sample insured for medical services through Blue Cross / Blue Shield (BC–BS).[14] The populations were not matched for benefit coverage, as Blue Shield subscribers were generally covered only for in-hospital medical care (in some cases only surgery). The ALS was similar for the two groups – 7.6 for HIP and 7.2 for BC–BS, and the age / sex standardized admission

11 See Klarman (1963, 956, Table 2). The PGPs considered were Kaiser, Group Health Cooperative (Seattle), and Labor Health Institute (St Louis).

12 HIP was designed to provide the subscriber with comprehensive medical care at any location (physician's office, hospital, or home) through any one of approximately thirty medical groups in the New York City area. The groups were reimbursed on a capitation basis (an agreed-on remuneration per patient-year regardless of the number of consultations), and individual physicians were not paid on a fee-for-service basis. The interested reader should consult Densen et al. (1958) for further details and Donabedian (1965) for a brief summary of this particular study.

13 The figures reported by Klarman (1963) for this study were 74 and 67 admissions per 1000 respectively. The higher figures incorporated estimated deaths which would have been admissions not picked up by the survey (Donabedian, 1965).

14 Blue Cross (BC) is the most common hospital insurance program in the United States. Blue Shield (BS) was the medical care insurance program. See Somers and Somers (1961) for a historical account of BC and BS development, scope of benefits, etc.

rates were 81.1 and 93.9 respectively.[15] Because of the differences in benefit coverage, and the possible incentives therefrom (to both consumer and provider) to substitute in-hospital medical or surgical care for ambulatory treatment, these data are unsuitable for assessing the ability of PGPs to reduce inappropriate hospitalization.

A household survey, done in 1955 in New York City by the Health Information Foundation (HIF) and the National Opinion Research Center (NORC), focused on the membership of three trade unions (Anderson and Sheatsley 1959). Union members were allowed a choice of membership: HIP or Group Health Insurance Plan (GHI).[16] The main difference between this and the second HIP study was that the benefit structure of GHI eliminated much of the disparity in coverage between populations in the earlier study. The age-sex adjusted admission rates were 63 and 110 for the HIP and GHI subscribers and 43 and 76 respectively for surgical admissions, while the ALS rates, similarly adjusted, were 6.5 and 8.0

In a 1960 study of hospital utilization patterns for members of the United Steelworkers of America, Falk and Senturia (1960) compared Kaiser Foundation Health Plan[17] subscribers with members insured through either BC-BS or a commercial plan in 1958. The samples were composed of steelworkers from various places, a procedure that of course precludes geographical standardization.[18] The unadjusted admission rates were 98 for Kaiser, 135 for BC-BS, and 150

15 Hereafter, unless otherwise noted, admission rates will be per 1000 population per year. MacColl (1966) estimated that the differential in admission rates could be translated into a gross expenditure saving of over $1.5 million (based on the then HIP membership of 500,000) and the elimination of 137 beds.

16 The GHI plan gave more extensive ambulatory medical coverage than Blue Shield in that subscribers were covered for general physician and specialist services in the home or office as well as in the hospital. As with Blue Shield, GHI paid physicians by fee-for-service, and subscribers had free choice of physician, with one qualification: consultation with a non-GHI-participating physician entailed some risk on the part of the consumer, since the non-GHI physicians, like the opted-out physicians in Ontario, could charge above the GHI fee schedule and the consumer was responsible for the difference. The GHI scheme is described in detail by Densen et al. (1960).

17 For comprehensive discussions of the Kaiser plan, the largest PGP in the United States, the reader might consult Somers (1971) and Williams (1971a). Further information on Kaiser is scattered throughout MacColl (1966).

18 See Donabedian (1965, 57) for a clear illustration of the danger in drawing conclusions from inter-regional rate comparisons. Using data from this particular study, his breakdown shows that BC-BS subscribers from the same union but from twenty-one geographical regions experienced average regional admission rates per 1000 subscribers ranging relatively evenly over the range 120-189 for a common time period. More recently, Gornick (1977) made a cross-regional comparison of discharge rates for medicare patients and found a wide range of rates around the American average of 304.6 in 1972. Maryland at 236 had the lowest rate, while North Dakota reported the highest rate, 425.6.

for the commercial plans. When one Kaiser group composed mostly of retirees was eliminated, the Kaiser rate dropped to 90.

It is perhaps significant (see Roemer 1961a) that Kaiser plans provide fewer acute care hospital beds per subscriber (approximately 2.0 per 1000; Williams (1971a) reports 1970 figures ranging from 1.4 in Ohio to 2.8 in Hawaii[19]) than the American average of approximately 4 per 1000. Unlike HIP and many other group plans, Kaiser owns and operates its own hospitals. One might be inclined to a *prima facie* conclusion that the lower bed/population ratio inhibits admissions, some of which could be 'necessary,' with obvious implications for quality of care. However, the opposite view, that lower admissions give rise to a need for fewer beds, is supported by the evidence from other prepaid group practices. Also of interest is the low ALS (6.4 days) for Kaiser plan members, in contrast to 7.6 days for BC-BS and 7.8 days for the commercial plans.

The fourth HIP study (Densen et al. 1960), like the third, compared the experiences of Blue Cross members of HIP with their counterparts in the GHI plan. Unlike in the former study, however, the data were not based on a household survey. Again, union members were given a choice between two plans, HIP or GHI. Using 1956-7 data, the authors found a significantly lower age/sex adjusted utilization rate (70.2 admissions) for HIP members than for GHI enrollees (88.3 admissions). There was little difference in ALS, and the difference in admission rates arose primarily from the female patients. This study provides the type of data on diagnostic disaggregation of utilization that are necessary for use with the diagnostic costs estimated below. Thus, the data from the study receive further scrutiny in Chapter 6. It is worth noting, however, that the authors reported a tonsillectomy rate for GHI subscribers approximately double that for HIP members, while admissions for cases likely to entail surgery, such as hernia, gall bladder conditions, haemorrhoids, and varicose veins were also substantially lower for the latter group.[20]

The fifth and last in the series of HIP studies (Densen et al. 1962) was unique in the sense that no significant differences were found in the comparative admission patterns. Once again union members were offered a choice of membership: HIP or a union-sponsored fee-for-service plan covering both medical and hospital care. The age-sex adjusted admission rates were 64.3 for HIP and 63.9 for the union plan, while the comparable non-obstetrical rates were 49.3 and 51.6 respectively. Again, a breakdown by diagnostic category is provided. While the

19 Eugene Vayda has pointed out that the figure of 1.4 for Ohio is not a true representation, since that branch of Kaiser Permanente also uses non-Kaiser-owned community beds.

20 Donabedian (1965) thoroughly dissects, analyses, and re-tabulates the diagnostic data from this article (see esp. 22-25, 59-60).

study did raise questions about the reason for the earlier significant differentials, the union plan differed from the BC-BS, GHI, and other commercial plans in that, as well as offering benefits coverage, it undertook (through a continuous education program aimed at both physicians and patients) to maintain effective control of utilization. The education program promoted an awareness of the use and costs of available facilities and emphasized the need for conservative use of resources. It would appear, then, that a rigid surveillance of expenditures, combined with an ongoing educational program, was propounded as a reasonable alternative where group practice was not feasible. The expense entailed in the administration and operation of such a program, however, (over and above medical expenses) was not estimated, or at least was not reported.

Since the extension of such an 'education' program to the entire Ontario population, both providers and patients, would be extremely expensive and of uncertain benefit, and since the purpose of the present study is to measure the possible effect of CHCs on hospital costs in Ontario, given the status quo, the diagnosis-specific utilization information in Densen et al. (1962) was not matched with our cost estimates. More recent evidence (Shapiro 1971) has supported the earlier HIP studies and suggested that the 1962 study was an exception rather than the rule.

A second American study from about the same time that also reported relatively invariant admission patterns (Williams et al. 1962) was based on a 1958 household survey unstandardized for geographic locale. A BC-BS sample was taken from the Newark NJ area, a sample of commercial subscribers was taken from various American cities, and the Kaiser sample consisted of blue collar union members in the San Francisco area. The reported admission rates were 79 for Kaiser, 71 for the commercial plan, and 76 for BC-BS subscribers (all rates unadjusted).[21] Approximately 8 per cent of hospital admissions for the Kaiser sample were to hospitals outside the Kaiser plan, a fact that will concern us further in the next section.

Kaiser, being the largest PGP in the United States, has been the subject of numerous studies of many types. Another in the series comparing Kaiser subscriber hospitalization with that of other groups (Dozier et al. 1964) improved

21 See Donabedian 1965, Klarman 1963, and Hetherington et al. 1975. Note that these particular commercial and BC-BS rates are markedly lower than most of the other reported rates for non-PGP settings. While inter-study comparisons are hazardous, it is perhaps worth emphasizing that this comparison may be 'softer' than many others since no geographical standardization was applied and the admission rates may again be downward-biased by inaccurate responses to the survey. Furthermore, sample sizes were so small as to virtually eliminate any chance of finding significant rate differences (Klarman 1963).

upon the study discussed above by imposing geographic standardization: the subscribers to all plans were California State employees and their dependants, or retired employees.[22] The data were for the period 1962-3 and showed admission rates of 62 for Kaiser, 104 for a commercial plan, and 96 for BC-BS (Donabedian 1965).

Another source of repeated studies providing comparative hospital utilization rates has been the United States Federal Employees Health Benefits Program (FEHBP). This is a voluntary government-sponsored health insurance program through which employees have the option of choosing membership in one of several different plans, among them BC-BS and group practice plans. As of 1974 more than nine million persons were covered by it.[23]

The FEHBP has been publishing utilization data since the early 1960s, and these data, although often not geographically standardized, give a nation-wide picture of utilization rate differences. Perrott (1966) compared, among other things, the non-maternity surgical procedure rates of employees covered by either BC-BS or group practice prepayment plans. The rates were 70 and 39 per 1000 persons per year respectively, unadjusted for age and sex, indicating close to 80 per cent greater frequency of surgical procedures for those employees covered by BC-BS and seeing fee-for-service physicians. When this 80 per cent differential is analysed, about one-third of it is accounted for by higher rates for tonsillectomies and adenoidectomies (10.6 vs. 4.0), appendectomies (2.6 vs. 1.4), and female surgery (hysterectomy, etc. 8.2 vs. 5.4). Perrott does not report general admission rates or ALS, but rather total non-maternity days per 1000 persons per year. For 1961-2 the rates were 454 for those enrolled in prepaid group practice plans, 826 for BC-BS, and anywhere from 538 to 729 for various other plans. Similar spans were reported for 1960-1 and 1962-3. For later comparative purposes, we note that one particular group, GHA, had a rate of 459, approximately the average for the group practice plans.[24]

Reporting in 1968 on the sixth term of coverage and utilization for the FEHBP, Perrott and Chase found that the fee-for-service plans had incurred 135 per cent more surgical procedures than the group plans (Williams 1971a, 83). For non-maternity admission rates, group plans reported 47 per 1000 subscribers, while the BC-BS rate was 101. Other plans ranged from 72 to 90 (Foulkes 1973a, 24).

22 Details of the retirement system can be found in MacColl (1966, 203-7).

23 See Riedel et al. (1975, xii-xiii) for further details.

24 The membership of GHA (Group Health Association, Inc., Washington DC) is made up largely of federal employees falling under the FEHBP. It is consumer-owned, and subscribers prepay for comprehensive care. A brief discussion of this group plan is contained in Riedel et al. (1975, xiii).

Perrott's seventh term report (1970) confirmed these significant differences in several surgical rates: tonsillectomies 200 per cent higher in fee-for-service plans, appendectomies 50 per cent higher, etc. (Williams 1971a, 93). Finally, a study covering 1961-8 (Perrott 1971) emphasized the consistency over that period of the significantly lower hospitalization rates for the PGP subscribers, in particular the differentials for elective surgery. The 1968 PGP non-maternity days rate of 422 was similar to that for 1961-2, while the commercial and BC-BS rates (987 and 924 respectively) showed marked increases over the earlier figures (Hetherington et al. 1975, 87).

Hasty inferences drawn from the FEHBP experience, however, are ill-advised. As noted earlier, many non-PGP plans had severe restrictions on non-hospital benefit coverage, and the plans covering the Federal Employees were no exception. Insured payments for out-of-hospital ambulatory services in 1968 were received by only 23 per cent of Blue Plan members and 17 per cent of commercial plan members. The group practice plans showed 73 per cent of their members having such services paid for in 1968.[25]

Most of the studies discussed above focused on a single union or employer and then compared the hospital utilization rates of two or more sub-groups within that larger population. In a project employing a somewhat different method (Roemer et al. 1972) BC-BS subscribers were found to have lower admission rates than employees of both provider-sponsored plans and prepaid group practice plans in the period 1967-9. Rather than analysing admission experiences for a particular occupational group with a choice of plans, this project first isolated six plans (two of each type) and then chose random consumer samples from within each plan. All subscribers were from the same geographic area, and the samples did not differ significantly in socioeconomic composition. A serious comparability problem arises, however, in that the extent of benefit coverage varied among the plans chosen (ibid., 11-12). Again, the prepaid group plans provided more extensive benefits than either the commercial (BC-BS) or provider (hospital or physician-sponsored) plans. Furthermore, the authors present evidence that the commercial plans succeeded in enrolling a lower percentage of high-risk persons than the other two plans. It is perhaps not surprising, then, that the PGP admission rate of 107 was slightly higher than the rate for the commercial (BC-BS) plan (102). The group practices were still significantly below the rate of 150 for the provider plans, and the PGP subscribers had a markedly lower ALS (4.9 days) than either of the other plans

25 Ibid. Lest one conclude from this evidence that greater ambulatory coverage is the cause of the lower hospitalization rates, the interested reader is referred to Hill and Veney (1970), a study discussed below.

(8.5 days for BC-BS; 7.4 days for the provider-sponsored plans). These figures were all based on a consumer survey. In an extension of this study, Hetherington et al. (1975) found the questionnaire responses to be biased estimates of actual hospital admission records, which showed rates of 76 for the PGPs, 145 for the commercial plans, and 151 for the provider-sponsored plans (ibid., 123); the ALS ranged from 4.8 days for Kaiser and one of the commercial plans to 9.1 for a hospital-sponsored plan, with the second PGP having a rate of 8.2 days.[26]

A recent comprehensive investigation of the differences in hospital utilization patterns among FEHBP members extends Perrott's earlier analyses of this group. The authors (Riedel et al. 1975) concentrate on subscribers to two plans: GHA and BC-BS. Not only do they report admission and ALS statistics, but they also provide a detailed disaggregation of these figures by diagnostic category. These data will be used later.

Not surprisingly in light of the earlier FEHBP studies, the reported admission rates of the group practice plan members were significantly lower than the corresponding BC-BS rates. The project's population samples were from the Washington DC area for the years 1967-70. Coverage was similar but not identical under the two plans, though the extent of coverage inequality would suggest that the benefit structure accounted for no more than a minimal share of the admission differences: 69.6 for GHA and 121.8 for BC-BS; non-obstetrical: 51.3 for GHA and 99.8 for BC-BS.[27]

Major differentials in diagnostic admissions (among those not explained by differences in coverage) occurred for disorders of menstruation, respiratory conditions, and diseases of the gallbladder. Admissions for tonsillectomies and adenoidectomies were again markedly lower for the prepaid group practice (age-and-sex-adjusted rates of 1.5 admissions per 1000 members years for GHA and 5.9 for BC-BS).

In a study that effectively standardized for hospital bed availability (to be discussed below as a possible cause of the utilization rate differentials) Wersinger et al. (1976) compared the hospital utilization experiences of three HMOs. The three, all in the Rochester area and 'with essentially the same access to the community's supply of hospital beds' (722) were an MCF, a PGP located in a single health centre, and a network of health centres (RHN). Peer review in the MCF occurred only for ambulatory services during the study period. The insurance burden for the MCF was carried by BC-BS, and physicians were reimbursed by fee-for-service. The health care network contained seven distinct group practices varying in staff composition and location (one was hospital-based) and in

26 The prepaid group practices were Kaiser and Ross-Loos.

27 Riedel et al. (1975, 19-21). Figures for total admissions were age- and sex-adjusted.

TABLE 3

Hospital utilization experiences of three HMOs in the Rochester area

	Admissions per 1000 persons per year	Difference from Blue Cross rate (%)
Blue Cross, 1972	74.4	—
MCF, 1974	85	+14.2
PGP, 1974	54	–27.4
RHN, 1974	70	– 5.9
MCF, 1973-4 fiscal year	79	+ 6.2
PGP, 1973-4 fiscal year	48	–35.5
RHN, 1973-4 fiscal year	63	–15.3

SOURCE: Wersinger et al. (1976)

method of remuneration (a mix of prepayment and fee-for-service). Blue Cross carried the hospital insurance for the network, and the financial risk for ambulatory care (other than outpatient hospital services) was shared by the network and Blue Shield.

In addition to inter-plan comparisons, the authors give BC-BS utilization figures. However, although the benefit structure was similar among the three plans, in all three it was more extensive than that available through BC-BS. The age-standardized admission rates reported are shown in Table 3.[28] The authors make a distinction between fiscal and calendar years because the HMO plans started in July 1973. In particular, 'the calendar year was added because of a larger enrolment base and because it avoided the initial 'warm-up' period when patients were taken in for first evaluations with possible delays in scheduling admissions' (Wersinger et al. 1976, 725).

It is especially interesting to note that the PGP plan's age-adjusted admission rates were 36 to 39 per cent lower than the comparable MCF rates and 23 to 24 per cent lower than the RHN rates. As the authors correctly emphasize, the combination of no financial risk to the organization or member physicians (in the MCF case) and the lack of peer review of hospital procedures are likely to be jointly responsible for the former differentials.

Despite Luft's (1978a) claim to the contrary, Perkoff et al. (1976) found that subscribers to the Medical Care Group of Washington University (MCG),

28 The 1972 Blue Cross under-age-65 sample was used as the base for age standardization. The rates reported here are exclusive of the over-65 groups and obstetric, nursery, and psychiatric admissions. The over-65 group was excluded because of the low enrolment from that population in the prepaid plans.

a PGP, incurred significantly fewer hospital care days than their matched population control group.[29] The admission rate for MCG (73) was also lower than that for the control (79), but because of the small sample sizes the difference was not statistically significant. It is interesting that surgical admissions were significantly greater for MCG males than for their control group counterparts, while the pattern was exactly the opposite for non-surgical admissions. The authors do not offer any definitive explanation for this experience, but they do note that the surgical differential pervaded all pertinent diagnostic categories.

A number of recent studies have compared the PGP and non-PGP hospitalization experiences of Medicaid recipients. Results from this type of comparison may be extrapolated to the general population only if there is no significant non-PGP-induced Medicaid/non-Medicaid utilization differential. In fact, some such evidence does exist (Greenlick et al. 1972, Sparer and Anderson 1973). Although Hester and Sussman (1974) question the robustness of that evidence, which is based on relatively small samples and in each case membership in only one PGP, and cite some troubling low utilization rates for Medicaid members of HIP, the experience of Medicaid recipients themselves is of interest, irrespective of extrapolability, since those recipients do and will continue to constitute a share of PGP enrolment.

Gaus et al. (1976) compared the hospital utilization of ten matched population pairs, covering three distinct types of HMOs – the standard PGP, the medical care foundation, and a PGP not at risk for its enrollees' hospitalization – for the period 1974-5. The data were obtained from a survey of random, geographically standardized HMO and non-HMO samples of Medicaid recipients. Those questioned were asked to recall hospital utilization for the six months preceding the interview. Admission rates for the PGPs taken as a group were 60 per cent lower than the comparable rates for the control sample (46 vs 114). Individual plan differentials ranged from 44 per cent (for HIP) to 82 per cent. In contrast, foundation subscribers were admitted to hospital approximately 15 per cent less often than their control counterparts. ALS rates were closer (7.4 for PGPs and 7.7 for the controls, and the authors suggested the possibility of some upward bias in the latter figure). Two specific points of emphasis are the surgical rates and

29 Luft (1978a, 1339) classifies the Perkoff et al. (1976) study as one 'of the six studies that indicate higher or equal total hospital utilization for prepaid-group-practice enrollees.' While the authors did a separate analysis of the hospitalization of control group enrollees who changed to the MCG during the study period and found that they used more hospital days when they were members of MCG than when they were part of the control group, the difference was not statistically significant. It is also unlikely that Luft would have so classified this study on the basis of a 'secondary' result.

out-of-plan use. The surgical admission differentials closely mirrored the pattern for all admissions, ranging from 33 to 70 per cent for the PGPs; one MCF had a surgical admission rate 8 per cent lower than the control, the other 32 per cent lower than its control. Out-of-plan utilization of both hospital and ambulatory facilities was under 1 per cent of total utilization. Hester and Sussman (1974) note that comparable results are reported in a similar study covering a longer period. In a study of a medical care foundation only, Holahan (1977) found no significant differences in total admissions or surgical admissions between members of a foundation and a matched population of Medicaid recipients. The foundation in this case was not at risk for its enrollees' inpatient hospitalization (with the exception of surgery). When it is also noted that the MCF physicians were paid on a fee-for-service basis, these results are not particularly surprising. Frech and Ginsburg (1978, 51) suggest that the same factors may underlie the small differentials for MCF subscribers reported by Gaus et al. (1976).

In an analysis of the medical care utilization of about 1000 Medicaid recipients in the period 1971-4, Fuller et al. (1977) obtained results similar to those of Gaus but used a different method. Rather than comparing the hospitalization experiences of matched Medicaid samples in and out of PGPs, they monitored the hospital utilization rates of a single sample of Medicaid recipients before and after enrolment in a PGP. The sample consisted mainly of single mothers with children under 19. The overall admission rate for this group in the twenty-two months before their enrolment in the PGP was 111.5. It dropped to 76 during the subsequent twenty-two months when the sample had become PGP subscribers. Both rates were lower than the 139 admissions per 1000 person-years for the entire Medicaid population of the District of Columbia in fiscal year 1972. The magnitude of the differential was similar for total patient days per 1000 subscribers: 412 after PGP enrolment versus 602 before; the control group figure for 1972 was 744. Thus, ALS was virtually identical in the two periods.

Johnson and Azevedo (1979) compared the hospital utilization of Kaiser plan enrolees with low incomes but not eligible for Medicaid with a matched (age and sex) group of Medicaid-eligible low income persons. Using 1972 data from Oregon, they found discharges and total days for Kaiser plan female members under age 65 to be significantly lower than for the control group. However, this Kaiser group also used hospitals significantly less than another matched Kaiser group *with* Medicaid eligibility. This latter finding seemed to indicate that 'some hospital use through the Medicaid program could have been questionable' (965).

In an analysis of 8450 residents of California during 1975, Blumberg (1980) compared the hospitalization rates of PGP enrollees and persons with and without other sources of private health insurance. The discharge rates, based on

survey recall, were 93.1 for PGP enrollees, and 104.6 and 126.4 respectively for those with and without other private coverage. The comparable non-obstetric episode rates were 75.1, 91.7, and 100.9 respectively, as PGP members had a higher crude birth rate than those with other private coverage.

Williams et al. (1979) compared the utilization of low-income members of a PGP with that of prepaid enrollees in an independent practice plan which reimbursed participating physicians on a fee-for-service basis. Admission rates (excluding obstetrics) were 78 and 119.6 respectively, with average lengths of stay of 4.5 and 5.2 days.

There is no single organizational entity that is representative of the HMO in the United States. In fact, there are numerous variations on the common theme (Wolinsky 1980). The literature describing and evaluating them is extensive and expanding rapidly.[30] But while this has undoubtedly been prompted by an increase in the number of HMOs in the United States[31] 'in response to favourable market conditions and high-level-policy encouragement from the federal government' (McNeil and Schlenker 1975), the road has not been easy. Legislation introduced in 1973 and 1974 which was purportedly intended to encourage further increases in the number of operating HMOs seemed destined to discourage such growth and possibly undermine the entire concept (ibid., Schroeder 1978, Starr 1976). This United States legislation required HMOs to offer a remarkably broad range of services not generally offered by their 'competition' and compelled them to provide an annual open enrolment period of at least thirty days. Angermeier (1976) gives some evidence that open enrolment did not jeopardize the financial viability of one particular plan. How true that will be of others remains to be seen. At the very least, all these stipulations increase the difficulty that HMOs will face in controlling costs and, more important, since 'similar costs will not have to be borne by those who compete with HMOs' (McNeil and Schlenker 1975, 218), it will probably weaken their competitive positions. HMOs that do not meet those standards will not receive certification. But HMOs must be certified if they are to qualify as one of the two options offered by employers. In effect, 'a double standard is created whereby HMOs are saddled with extra requirements such as more comprehensive benefit packages,

30 The literature is in fact so extensive as to merit its own bibliography (see for example United States 1974 and 1979).

31 The number of prepaid plans in the United States grew from 23 in 1969 to 215 a decade later. California continues to be the main location, with 14 per cent of the plans and over 45 per cent of the prepaid enrollees (United States 1979). This is partially due to the presence of the large Kaiser Foundation Health Plan in that state (Goldberg and Greenberg 1979).

open enrolment, community rating, cumbersome co-payment provision, mandatory quality assurance systems, and restrictions on the degree to which participating physicians can participate in fee-for-service practice' (Schroeder 1978, 179). It seems safe to say that this bureaucratic confusion has discouraged and, for as long as it remains in place, will continue to discourage the birth of new HMOs (Goldberg and Greenberg 1979). One can only guess at its long-term effects on older HMOs and on the HMO program in general. Where HMOs have gained a significant market share, it has been argued that the traditional plans have responded in a competitive manner (ibid.), although in those settings and elsewhere the evidence still seems equivocal (Luft 1980a).

In contrast, there seem to be few equivalents to HMOs in Canada and little descriptive and evaluative literature. With the exception of Quebec, where in 1978 there were eighty operative CHCs (or CLSCs as they are called there) in operation (Brunet 1978), there has been no concerted effort to encourage and support these clinics in Canada. The rest of this section reviews the experiences of the oldest Canadian CHCs, those in Saskatchewan. The next section considers in some detail the limited Ontario experience.

Despite the difference in health care financing, the Canadian experience, such as it is, has generally been similar to the American, although cross-border comparisons are likely to be fraught with biases.[32]

The comprehensive group practices in Saskatchewan were born from the infamous twenty-three day 'Doctors' Strike' of 1962 (Badgley and Wolfe 1967). The first major evaluation of the three largest clinics was made in 1970 and 1971 by Anderson and Crichton (1973), who investigated the effects on hospital utilization of the community clinics in Prince Albert, Saskatoon, and Regina. In fact, however, the rates reported are not linked with a particular clinic but are presented for five unidentified regions. Three each contain one of the community clinics noted above.

32 Except where otherwise stated, Canadian admission or separation rates are for adults and children and are thus comparable with American rates, which also exclude newborns. There is, however, some question about the comparability of the chronic/acute bed mix in the hospitals supplying data from each side of the border. Canadian hospital data are usually disaggregated by hospital type — general and allied special, mental, tuberculosis, federal, etc. The first of these supply the Canadian data relevant to this study. The most closely corresponding group in the United States comprises the 'non-federal short-term general and other special' hospitals. The bed mix in these two groups may not be exactly comparable, since another category in the United States is the 'non-federal long-term general and other special' hospitals. It is conceivable that some patients admitted to such hospitals, and thus not included in the American data reviewed, would (given the same disease in Canada) have been admitted to 'general and allied special' hospitals.

Within regions containing community clinics the CHCs had lower separation rates than either general practices or other clinics. The differentials ranged from a CHC advantage over general practice of more than 36 per cent in one region to a scant 4.3 per cent advantage in another. What is striking, however, is the disparity among regions in the community clinic rates themselves – 144.5, 157.8, and 235.9 for the three clinics. The third of these was located in a rural area where hospitalization rates tend to be higher. The study also found lower rates of elective surgery in the comprehensive clinics, while the clinics undertook more investigative procedures and referrals.[33]

A second study of the hospital utilization experience of these three Saskatchewan community health association clinics (CHACs) produced comparable results (McPhee 1973). The discharge rates, adjusted for age and sex, for enrollees who contacted physicians at least twice during the study period were as follows:

	CHAC	Non-CHAC
Prince Albert	235	303
Saskatoon	173	226
Regina	186	229

Although no diagnostic breakdown of separations or days' stay was included in the study, such separation data have been obtained and are used in Chapter 6. These numbers, unlike those deriving from two-option situations, for example, are based on user populations rather than enrolled subscriber populations. That is, the study compared hospitalization rates only for those segments of the populations that had two or more physician contacts during the study period. It ignored the three segments of the theoretical subscriber population described below.

Restricting the sample to persons who also saw a physician at least twice eliminates four other groups from the total population of potential users: those who had no contact with a physician or hospital, those were hospitalized without any ambulatory contact with a physician (e.g. directly from an emergency department), and those who contacted a physician only once during the study period divided into hospital users and non-users. Unless one knows or can

33 Commenting on the apparent lack of a consistent pattern among the various clinics studied, Foulkes (1973a) suggests that the explanation may be found in the failure at that time of the clinics to institute a prepayment system. The clinics were still operating on a fee-for-service basis; in other words, one of the main requisites in the CHC ideology was still missing. The clinics had to generate operating income in the same manner as a solo fee-for-service physician, although the physicians themselves were not paid in that way.

assume that the comparison populations falling into these four groups are subject to similar patterns of treatment or lack of treatment, one risks drawing conclusions from biased data sets. In short, any attempt to develop utilization rate denominators in the absence of self-defined ones will be fraught with difficulties. This issue is taken up again later.

In 1972 the fee-for-service method of payment to these clinics was replaced by a global budget for each clinic. All physicians continue to be paid salaries 'based on training, qualifications, and experience [that] approximate the average net income of comparable physicians billing fee-for-item-of-service' (Bury 1978, 3). Although the CHC 'movement' in Saskatchewan may not be thriving (from ten clinics in 1965 there were only seven in 1978), three large CHACs have survived considerable turmoil, and are today alive, seemingly healthy, and all more than fifteen years old.[34]

The studies reviewed in this section all have a common theme – a comparison of hospital utilization rates for PGP/CHC subscribers with those of comparable non-HMO samples. Table 4 attempts to compile and summarize the admission and ALS differentials as well as to show the extent of standardization. As noted earlier, the diagnosis-specific differentials provided by three of these studies (Densen et al. 1960, McPhee 1973, and Riedel et al. 1975) are used in deriving hospital cost saving estimates in Chapter 6.

Lengthy as this review may seem, it is by no means exhaustive. Other studies are reviewed (or at least referred to) by Donabedian (1969), Klarman, (1963), MacColl (1966), Roemer and Shonick (1973), Wolinsky (1980), and Luft (1978a, 1980). An early review of the state of practice organization research is Weinerman (1966). In addition, a number of the PGPs (in particular the Kaiser group) often publish statistics similar to the ones reported here. Finally, a small number of studies for Ontario are discussed in the next section.

THE ONTARIO EXPERIENCE

In Ontario comparative studies have been limited to two CHCs – one in Sault Ste Marie, the other in St Catharines. This section recounts briefly their histories, reviews the literature that has assessed their hospitalization records, and concludes with some comments on the recent status of these clinics and of the CHC 'movement' in Ontario.

34 Of course 'health' may be in the eye of the beholder: I was told recently that all has not been tranquil in the Regina program.

TABLE 4

Summary of hospital utilization data

	Admission or discharge rates per 1000 patients			Average length of stay in days for patients of:		
Study	PGP or CHC	Private practice/ private insurance	Percentage difference (PGP minus private)/ private	PGP or CHC	Private practice/ private insurance	Comments
U.S. studies						
President's Commission on the Health Needs of the Nation (1952)	70-104	122	–14.8 to –42.6	6.2 to 7.0	7.4	Populations not matched; benefits not the same
Committee for the Special Research Project in the Health Insurance Plan of Greater New York (1957)	74	67	10.4	10.6	11.6	Populations not matched; benefits not the same; household survey.
	81	74	9.5			Adjusted for deaths not recorded by survey.
Densen et al. (1958)	77.4	95.8	–19.2	7.6	7.2	Geographically matched; benefits not the same.
	81.1	93.9	–13.6			Age-sex adjusted rates.
Anderson and Sheatsley (1959)	63	110	–42.7	6.5	8.0	Two options; fairly comparable benefits; household survey; age-sex adjusted rates.
	43	76	–43.4			Surgical admissions only.

TABLE 4 continued

Study	Admission or discharge rates per 1000 patients: PGP or CHC	Private practice/private insurance	Percentage difference (PGP minus private)/private	Average length of stay in days for patients of: PGP or CHC	Private practice/private insurance	Comments
Falk and Senturia (1960)	98	135-150	–27.4 to –34.7	6.4	7.6-7.8	Common employment group but no geographic standardization; unadjusted rates.
Densen et al. (1960)	70.2	88.3	–20.5	10.4	10.8	Two options; adjusted for age, sex, geographic locale and union local composition.
Densen et al. (1962)	64.3	63.9	0.6	8.3	8.4	Two options; adjusted for age, sex, geographic, and union local composition; control group was union-sponsored
Williams et al. (1962)	79	71-76	11.3 to 3.9	7.7	7.6-8.6	Populations not geographically matched; household survey; small samples.
Dozier et al. (1964)	62	96-104	–35.4 to –40.4	—	—	Geographic standardization, unadjusted otherwise.
Roemer et al. (1972)	107	102-150	4.9 to –28.7	4.9	7.4-8.5	Geographic and some socioeconomic standardization; benefit coverage varied, as did subscriber risk classes; household survey.
Hetherington et al. (1975)	76	145-151	–47.6 to –49.7	4.8 to 8.2	4.8-9.1	As for Roemer et al. (1972) above, except based on hospital records rather than survey, and using a smaller sample.

TABLE 4 continued

Study	Admission or discharge rates per 1000 patients			Average length of stay in days for patients of:		Comments
	PGP or CHC	Private practice/ private insurance	Percentage difference (PGP minus private)/ private	PGP or CHC	Private practice/ private insurance	
Riedel et al. (1975)	69.6	121.8	–42.9	6.6	6.5	Standardized for age and sex; benefit structures similar; geographic standardization.
Wersinger et al. (1976)	48-54	74.4	–27.4 to –35.5	–	–	Rates for medical and surgical services only (i.e. exclude obstetrics, nursery, psychiatric, etc.); age standardized; geographic standardization; benefit structures somewhat different.
Perkoff et al. (1976)	73	79	– 7.6	7.0	8.4	Geographic standardization; control group subject to deductibles and/or coinsurance for medical benefits; hospital benefits identical; rates exclude obstetrics.
Gaus et al. (1976)	26-74	76 to 146	–44 to –82	4.6 to 13.7	5.4 to 16.3	Eight separate comparisons; intra- but not inter-comparison age and sex standardization; comparable benefits; geographic standardization for each comparison.
Fuller et al. (1977)	76	111.5	–31.8	5.8	6.3	Same sample used to derive pre-PGP and post-PGP membership hospitalization rates.

TABLE 4 continued

Study	Admission or discharge rates per 1000 patients: PGP or CHC	Admission or discharge rates per 1000 patients: Private practice/ private insurance	Admission or discharge rates per 1000 patients: Percentage difference (PGP minus private)/ private	Average length of stay in days for patients of: PGP or CHC	Average length of stay in days for patients of: Private practice/ private insurance	Comments
Johnson and Azevedo (1979)	89	150	–40.7	4.6	3.9	Discharge rates exclude abortions, while ALS includes them. All figures are for females under 65 years of age; comparable benefits; age standardized
Williams et al. (1979)	78.0	119.6	–34.8	4.5	5.2	PGP vs prepaid independent practice plan. Comparable sex and perceived health status. Minor differences in age, race, education, and family size and composition. Excluding obstetrics.
	110.1	140.4	–21.6	5.2	5.6	Including obstetrics.
Blumberg (1980)	93.1	104.6	–11.0	5.0	5.8	Based on survey responses; geographic standardization; rates for under 65 years; no age-sex standardization; health status fairly comparable. Including obstetrics.
	75.1	91.7	–18.1			Excluding obstetrics.
Canadian studies						
Anderson and Crichton (1973)	144.5	227.5	–36.5	9.48	9.43	Age-sex adjusted; geographic, benefit coverage standardization.
	157.8	164.8	– 4.2	10.73	10.73	
	235.9	280-289	–17.1	9.25	10.2-13.4	
McPhee (1973)	235	303	–22.4	9.1	9.7	Age-sex, geographic, benefit coverage standardization. Persons with at least two physician contacts.
	173	226	–23.5	7.9	8.6	
	186	229	–18.8	9.1	9.4	

The driving force behind the CHC at Sault Ste Marie was the United Steelworkers' union.[35] The Sault Ste Marie and District Group Health Association (GHA) was established in 1963, partially in emulation of the Kaiser model, with an initial enrolment of 16,000 (DeFriese 1975). By the end of 1975, it had almost 34,000 members, who were serviced by twenty-eight full-time-equivalent physicians. But the road has been anything but smooth, and the present method of financing health care in Canada has raised serious doubts about the future of this clinic and other ones like it in this country (Vayda 1977).

Although the clinic was not able to replicate fully the Kaiser setting (for example, it has never owned its own hospital), it did in the formative stages incorporate many of the more important PGP features – non-profit, salaried physicians, and prepayment by patients. In its early days it encountered obstacles in the community. Opposition from the private practitioners of the city to this incursion of 'socialized medicine,' which also defied the ethical code by actively soliciting members, led to innumerable unpleasant conflicts (Korcok 1972, DeFriese 1975, Vayda 1977). The clinic, however, had the not inconsiderable support of the union members, who constituted a significant portion of the total Sault Ste Marie work force. Over 70 per cent of the families that were offered the choice of participating in the clinic or continuing to receive care from private practitioners chose CHC membership (Korcok 1972). Each family that enrolled paid a premium (partly subsidized by the employer).

The first published evaluation of service utilization by subscribers to the clinic was done under the direction of John Hastings (Hastings et al. 1970, 1973) by the World Health Organization. The utilization data were based on the 1967-8 experiences of the CHC and samples matched from a commercial plan. The latter, of course, reimbursed the private practitioners on a fee-for-service basis. The geographical location and extent of coverage were almost identical. While the study included a diagnostically disaggregated analysis of the hospital utilization differentials (Hastings et al. 1973), the small size of the sample (about 3300 persons) precluded a fine diagnostic breakdown. The implications of using this partly disaggregated diagnosis-specific information in conjunction with our marginal cost estimates is discussed in detail in Chapter 6.

The discharge rates were 109.4 for GHA and 136.4 for the commercial plan (Prudential) subscribers. The GHA members also incurred fewer hospital days as a result of the discharge differential and a lower ALS: 8.95 for GHA and 9.32 for Prudential. The main difference in discharges was in respiratory conditions, although GHA enrollees also received significantly less surgery, in particular of

35 The events leading up to the establishment of the clinic are described in Goldberg (1962).

the pharynx, tonsils, and adenoids. Perhaps the most dramatic single differential was the tonsillectomy and adenoidectomy rates for children aged 10-14. Rates per 1000 children per year were 8.8 for GHA and 26.7 for Prudential. But it was a case not so much of Prudential subscribers receiving this surgery with abnormally high frequency as of GHA members having those tissues removed significantly less often than average – the rate for this procedure in the Algoma district for the period 1964-9 was 27.3. (The utilization differentials by diagnosis are reproduced in Chapter 6.)

By the time this evaluation was done, however, a fundamental change in Canadian health care financing was affecting the ability of the GHA clinic to maintain those differentials. With the introduction in 1969 of universal first-dollar medical insurance for the entire Canadian population, the concepts of prepayment and a pre-defined enrolled membership became effectively obsolete. Subscribers to GHA were now subject to no financial risk from seeking and receiving care from non-group physicians. Yet the CHC was at risk for all services consumed by its enrolled membership.[36] Prepayment was replaced by an agreement between the centre and the Ontario Ministry of Health whereby a capitation payment based on the enrolled membership was made to the centre. But while the amount of capitation was based 'essentially on the average rates of health care costs as they existed in the province at the time for the pay direct segment of the population' (Korcok 1972, 898), the members were not bound to receive all their care from CHC physicians.

Although concurrent provision was made for the CHC to receive 'incentive payments' related to hospital utilization, the clinic lost much of its control over subscriber hospitalization. It is not surprising, then, that 'medical services obtained outside the Plan increased in cost from 55 cents per member per month in 1969 to ... $1.84 in 1976' (Vayda 1977, 384).[37]

36 In fact, this was not the CHC's first experience with unrestricted freedom of choice of provider for its members. In 1966 the clinic had instituted an 'interselection' process allowing that choice and placing the clinic at risk for the cost of any outside ambulatory care. Mott et al. (1973) report however that 89.6 per cent of all ambulatory care provided to members was given at the GHA site.

37 In fact, whereas before 1969 membership was determined by the number of prepaid subscribers, defining a 'member' is now left to algorithms used by the Ministry of Health for determining payment to the clinic. The Ministry must decide which recipients of care from the clinic qualify as capitation enrollees. All other services provided by the clinic are reimbursed on a fee-for-service basis. A person who receives at least 60 per cent of his ambulatory services in any twelve-month period is deemed to have been a capitation enrollee over that period. Thus, at any given time the physicians in the clinic will not be able to differentiate capitation from fee-for-service patients. By 1976 it was estimated that 25 per cent of all ambulatory services were provided by the clinic to fee-for-service patients.

Part of this increased cost was a result of a rise in the hospital discharge rate from 104.6 in 1968 to 150 in 1973.[38] Because the new payment mechanism stipulated that the clinic was to be 'rewarded' for reduced hospital utilization rates, a second study was commissioned in 1971 to analyse its hospitalization experience. Not surprisingly, the authors found an increased rate of 1228 days (in contrast to the 979 reported in 1969–70 by Hastings et al. 1973). But even at that, the rate was lower than the provincial rate (age- and sex-adjusted) of 1373 days (Korcok 1972). The study also concluded that when increased ambulatory services for CHC subscribers were taken into account, it turned out that the CHC did not save anyone anything (*Ontario Medical Review* 1974, Korcok 1974). Given the environment in which the clinic was operating, this was hardly surprising.

Unfortunately these results led to serious questions being asked within the Ministry (then Department) of Health. As Dr Kinloch, then Director of the Medical Services Branch, commented: 'When they were operating with a reasonably locked-in population, there's no reason to think they could not achieve these kinds of savings, but the minute the provincial program came in all that changed. We must look at the experience of the Sault as starting in October 1969' (Korcok 1972, 900). Of course the relevant portion of the Sault experience depends critically on the questions being addressed. From Dr Kinloch's perspective of having to decide the future role of this CHC after health care financing was drastically changed, that may have been valid. But the CHC ceased, by definition, to be in the PGP mould in October 1969. For our interest in matched PGP/non-PGP hospitalization experiences, the post-1969 record of the Sault clinic has little more than curiosity value. Analysis of its members' hospital utilization rates since 1969 tells us nothing about the potential impact of a PGP on rates of hospitalization (Vayda 1973).

In light of this fact, two recent studies are only mentioned briefly, more for the sake of completeness than for subsequent use. DeFriese (1975) compared the results of the Hastings et al. study (1973) with responses from a household survey done in 1973. The author investigated how the advent of universal insurance affected the patterns of medical and hospital utilization for users of the Sault clinic. A random sample of Sault Ste Marie residents was drawn up and the respondents were grouped according to their main source of ambulatory care. Admission rates were 135.6 for households classified as having at least one GHA

38 These figures are taken from DeFriese (1975). The discrepancy between 104.6 and 109.4 reported by Hastings et al. (1973) results from their being obtained from different sources. The lower figure was based on a household survey, while the figures reported by Hastings were compiled from discharge records for a sample of the clinic membership.

member; 169.8 for households with no 'members' but who used the GHA facilities; and 166.8 for households who did not receive any services from the GHA clinic. When aggregated one step further, the rate became 149.8 for users (to any degree) of the clinic. Thus, while the GHA rate was considerably higher than that reported by Hastings et al. (1973), so too had the non-GHA admission (discharge) rates risen over the same period, so that those who used the clinic at least moderately were hospitalized 10 per cent less often than non-users.

In 1973 the Ontario Ministry of Health undertook internal evaluations of both the Sault Ste Marie and the St Catharines clinics. The final report on the Sault clinic compared the utilization experience of GHA capitation enrollees with that of patients who received at least 60 per cent of their ambulatory care from a 'comparable' comprehensive clinic in the period 1 April 1974 to 31 March 1975 (Ontario 1976a). The comparison clinic was in a different place, offered a different mix of services, and was reimbursed entirely on a fee-for-service basis. One wonders where the comparability came in.

The study did incorporate some age/sex standardization of the patient groups, but no other consumer characteristics (socioeconomic) were mentioned. The authors of the study acknowledged their lack of standardization and a number of other potentially serious differences between the clinics and the populations they served. The age/sex adjusted admission rates were 183.1 for the GHA clinic and 172.6 for the 'control.' The average lengths of stay were essentially identical in the two settings. Although the study does provide a breakdown of hospital utilization experiences by diagnosis, the absence of any matching of populations and the confounding influence of universal insurance prevent the use of the disaggregated data with the present study's cost estimates.

While the Sault Ste Marie clinic has had a stormy history and faces an uncertain future, by contrast the St Catharines clinic was never really given the opportunity to develop a history in the PGP mould. Again the impetus for creation of the St Catharines and District Community Group Health Foundation came from a union, and again the union leaders were confronted with complaints from members about extra billing by physicians, inadequate access to services in off-peak hours, and rebuffs by closed practices. The discussions and negotiations that eventually led to the creation of the CHC started in 1964 when the United Auto Workers won the right of choosing between two medical care options in contract negotiations with General Motors.[39] The only problem, of course, was to provide the second option. The period from 1964 to 1967 was taken up with defining the role and the legal and organizational characteristics

39 This information is but a selective summary of an excellent historical description of the development of the St Catharines CHC by Tulchinsky (1970).

of the foundation. The detailed planning and implementation were done from 1967 to 1969 (Tulchinsky 1970). The prepaid two-option program finally began in August 1969, exactly two months before the establishment of the Ontario Health Services Insurance Plan (OHSIP – Ontario's entry into Canada's universal first-dollar insurance program). In fact, the CHC's organizers received approval for the program three days before the Ontario government announced its entry into the universal plan (ibid., 42). Thus, while the St Catharines clinic avoided the type of confrontation with the established medical profession that made the early life of the Sault clinic so difficult, the timing of OHSIP ensured that the St Catharines plan would not be permitted the growth time necessary to establish a prepaid clientele.

With the introduction of OHSIP, different financing arrangements were necessary for the St Catharines CHC. When the universal plan went into operation on 1 October 1969, the Ministry began a capitation arrangement with the clinic that incorporated a 'free choice' option. Again, 'subscribers' were free to seek care from non-clinic providers. Out-of-plan use was, from the start, higher among the St Catharines clinic population than it had been (and was) at the Sault.[40]

When the St Catharines CHC opened, it had enrolled around 6000 persons. By June 1970 the number had grown to 10,000, but many of them were enrollees in name only: they continued to receive the bulk of their care outside the plan. The clinic was at that time also treating a significant number of non-enrolled patients on a fee-for-service basis. In 1970 the capitation base was adjusted to exclude those persons receiving significant amounts of outside care. The foundation remained responsible for outside services provided to capitation enrollees. The CHC soon found it impossible to function on this financial basis and the capitation arrangement was abandoned in 1971 in favour of line-by-line budgeting (Ontario 1976b). In 1973 the clinic began to be reimbursed on a cost basis (Vayda 1977).

Given this history, any CHC vs matched population study of hospitalization is ruled out. When the Ministry of Health began its study of the Sault clinic, it undertook a similar study of the St Catharines plan. Again, experience was related to that of a 'comparable' control clinic, and standardization problems similar to those for the Sault study were no less prevalent or important here. In fact, the inherent methodological problems are captured by a statement in the St Catharines study: 'Variables associated with the providers (clinics) rather than

40 In fact, out-of-plan use by capitation enrollees was close to 50 per cent of total ambulatory care and hospital admissions (Korcok 1974). More recently, out-of-plan use was still running at a rate close to 40 per cent (Vayda 1977). This points out again the difficulty of defining subscriber populations in a universal insurance environment.

socioeconomic variables associated with the recipients of care were used to select the comparison group' (Ontario 1976b, 11). For the record the St Catharines Foundation users were admitted to hospital at an age/sex adjusted rate of 156, which was 8.8 per cent less often than users of the comparison clinic. A more significant difference was found in the average lengths of stay: 6 days for St Catharines vs 7.2 days for the 'control'.

In light of the unsuitability of the St Catharines study either for drawing inferences about the effects of PGPs on hospitalization or for using its diagnosis-specific utilization data, examination of further details is left to the interested reader. It is clear that any significant differences in hospital utilization reported by the St Catharines study have little, if anything, to do with comparisons of PGP/non-PGP matched population hospitalization.

Not that the St Catharines experience is without value. Indeed, it provides a vivid example of the problems to be expected in implementing CHCs within the framework of universal insurance. While the Sault clinic had the advantage of six or seven years of consolidation before OHSIP was set up, any future CHCs would not be so blessed. For them the St Catharines model may be a more useful lesson.

Where does this leave the future of CHCs in Ontario? It is clear that under the present arrangement even the CHC in Sault Ste Marie cannot be expected to 'produce' hospital utilization differentials like the ones it had in its pre-OHSIP days or like those reported by the American PGPs. Consequently, total health care cost savings for services rendered to 'capitation enrollees' will be an elusive objective. It would appear then that there would have to be other equally strong and empirically verified justifications for the delivery of care through CHCs if the clinics' existence were to be supported in the absence of changes in the enrolment arrangements. 'Unless ways are developed to deal with the problems of enrolment, opposition, and capitalization, prepaid group practice may never become a factor in Canadian health care delivery' (Vayda 1977, 388).[41]

A recurring pattern has suggested itself in most of the data reviewed so far. In fact, the incidence of utilization differentials 'favoring' the PGP/CHC settings suggests that non-random forces are at work. The data are, at the very least, consistent with the hypothesis that PGPs and CHCs generate lower rates of

41 Despite the rather bleak picture painted here, new groups patterned on the CHC model were being started. They were generally small (employing an average of fewer than four physicians) and were paid on a capitation basis, but their physicians were on salary and a selection of ancillary personnel and services was included. In fact nearly thirty such centres recently in operation across Ontario commanded an $8.8 million slice of the provincial budget ('The doctors' office patients help run,' *Toronto Star*, 4 November 1978, C6).

hospital utilization than comparable alternative plans employing private practitioners.

Many of the studies reviewed here suggested various plausible explanations for the differentials they reported. We now consider more rigorously a number of these.

BEHAVIOURAL AND ORGANIZATIONAL CONSIDERATIONS

There is an abundance of hospital utilization data available to researchers in the United States and Canada. Collecting and comparing various bodies of hospital data is therefore not difficult. As we have seen there has been a proliferation of analyses of comparative hospitalization experiences even within the relatively narrow field of HMOs. But the simplicity ends with the compilation and comparison of data. The interpretation of such comparisons is fraught with ambiguities.

Interpreting the hospital utilization differentials reported in the matched population studies of PGPs is important if one wishes to estimate the effect on hospital expenditure of an expanded role for CHCs in the Ontario health care system. That estimate will depend critically on the reasons for the past success of PGPs in reducing inpatient care. Unless we understand the behavioural, structural, and organizational reasons for the consistent PGP advantage in admissions experience, we cannot determine whether such a pattern would be likely to continue in the future and in Ontario.

The necessary standardization conditions for comparison of matched-population PGP versus non-PGP settings were stipulated earlier. The studies reviewed were unable to satisfy all those conditions. Nevertheless, by examining how patients come to receive inpatient care, one may draw on those studies to evaluate the factors underlying the reported inpatient utilization differentials.

Many of the variables that interact in the hospital admission process affect both sides of a matched population equally and can be quickly eliminated from the list of potential determinants of the differentials. It is on other variables not so easily eliminated that the various studies reviewed in this chapter, and other literature, can shed some light.

Our attention will be devoted primarily to the admission phenomenon. The two previous sections illustrated that the persistent and significant PGP/non-PGP differences in total hospital days were usually the result of similar differences in admission (or discharge) rates. The evidence on ALS was mixed, with no evident pattern favouring one mode of delivery over the other.[42] The framework sug-

42 See also Luft (1978a). Referring to the early HIP results, Klarman (1963) suggested that ALS rates adjusted for HIP's elimination of many potential short-stay patients would probably

gested by Roemer and Shain (1959) is adopted to a large extent in the following discussion.[43]

The admission of a person to hospital as an inpatient is preceded by the interaction of many factors that lead to identification of a 'need' for hospitalization. In a sense the admission itself is often the outcome of a process of demand and supply interaction within the agency relationship between patient and physician. The patient is almost exclusively responsible for initiating any given course of treatment. For conditions brought to a physician's attention by the patient, rather than those discovered during a routine physical examination or treatment for a different condition, it is the patient's belief that he or she needs treatment that precedes contact with the health care delivery system.[44] Once the patient is aware of an illness or condition requiring professional care, he or she usually enters the medical care delivery system by contacting a nurse or physician practising in one of the organizations on the spectrum described earlier. At this point, the attending physician begins an interaction with the patient that will determine the extent of future utilization of medical care resources during that episode of illness. In fact, it is often argued that this point marks the beginning of a physician-dominated utilization process.[45]

For convenience, we divide the factors that may underly hospital utilization data into three groups – patient, physician, and hospital – and consider the influence of each in 'creating' the utilization differentials reviewed above.

Patient factors

The main 'patient' variable underlying the extent of hospital utilization is almost certainly the incidence and prevalence of illness, the natural occurrence and

indicate shorter average length of hospital stay for a comparable case mix of HIP subscribers. Luft (1978a, 1340) tests this hypothesis on the diagnostic breakdown provided by Riedel et al. (1975) and finds no support for that contention. The difference in ALS when HMO members' average diagnosis-specific lengths of stay were weighted by the control group's mix of cases was not substantial.

43 In particular, a more comprehensive discussion of many of the individual variables considered in this section may be found in Roemer and Shain (1959). We shall only consider the scope each variable might have for influencing differences in hospital utilization patterns.

44 Note that it is the belief that initiates the process. There may be a significant 'need' that goes unattended if patients are unaware of the existence of a condition requiring medical attention or are unwilling to seek care. For a more complete discussion of the implications of unperceived needs for the modelling of the demand for health care, see Stoddart (1975).

45 The literature supporting this contention is voluminous and still growing, but the topic is far beyond the scope of this paper. For a recent summary of the evidence supporting this 'demand generation' theory, see Evans and Wolfson (1978).

existence of illness within a given population.[46] It is not unreasonable to expect the incidence and prevalence of illness to vary across regions, countries, or even cities. But they may also vary across geographically standardized population samples using alternative sources of primary care. The inter-regional influence may be dismissed, for, as we emphasized above, geographical variation in utilization rates renders non-geographically standardized data useless in this type of analysis. Most of the studies reviewed in which utilization differentials were reported used geographically matched populations. Within such studies, however, the potential influence of incidence and prevalence of illness must be considered more seriously.

If the health status of PGP subscribers is consistently higher than that of their control-group counterparts at the beginning of these studies, then the consistently lower admission rates for PGP enrollees would hardly be surprising. There seem to be two explanations of why any differences in health status might emerge, though they reflect opposing tendencies. First, since PGPs are reimbursed on a non-fee-for-service basis, they are at financial risk for the services used by their members. It would be in their interest, the argument goes, to select patients who are at least initially healthy and not likely to require an inordinate amount of care. On the other hand many of the studies reviewed reported evidence deriving from two-option situations. Here one might expect the self-selection process to influence subscriber composition. If PGPs, as so often happened, offered a more comprehensive range of 'covered' services or did not institute any direct charges (as the process of becoming a subscriber entailed prepayment), then those persons who expected to have a relatively high level of utilization would be inclined to choose PGP membership (Berki and Ashcraft 1980).

In the latter case, however, it would be difficult to differentiate between the influences of health status and benefit coverage. The role of differential benefit coverage is described below.[47] Where benefit coverage is equivalent, 'it could be postulated that a self-selection occurred as a result of basic differences between the individuals in the two study populations in their attitudes towards medical

46 The distinction between the two concepts is one of stock versus flow: prevalence refers to the extent to which the illness is present in the population at a given time, while incidence refers to the rate of occurrence of a particular disease during a given period.

47 By benefit coverage is meant both the range of covered services and the extent of direct charges to patients. If two plans offer coverage for an identical mix of services but one contains a major-risk feature, benefit coverage is obviously not comparable. Similarly, if two plans offer 100 per cent coverage but one of them extends this over a broader range of services, benefit coverage cannot be considered comparable.

care or towards their own health status' (Densen et al. 1960, 1721). But 'patient attitudes toward, and awareness of, illness' is, like benefit coverage, a quite separate variable from health status itself. Even with plans identically matched in benefit coverage and enrollees identically matched in each plan in 'attitudes and awareness,' we would still expect differences in health status to be reflected in different hospitalization rates.

But are such differences significant enough to be responsible for the consistently significant hospital admission differentials? Hetherington et al. (1975) and Roemer et al. (1972) 'found that significantly higher proportions of persons with generally greater risk of sickness were members of PGP organizations than were in commercial insurance or provider-sponsored ... plans' (Roemer and Shonick 1973). Whether this was a function of differential benefit coverage, different attitudes, or random differences in health status, however, is open to question. Certainly benefit coverage differences did exist across the six types of plans analysed (Hetherington et al. 1975, 53). More recently, Eggers (1980) looked at the pre-HMO-enrolment utilization pattern of a group of aged medicare beneficiaries. A comparison of the utilization of this group before they became members of the Group Health Co-operative of Puget Sound (GHC) through open enrolment, with a control group of medicare beneficiaries from the same area, showed the GHC group with markedly lower pre-enrolment utilization than their control counterparts. In particular, the GHC enrollees used inpatient services at a rate less than 50 per cent of that of the controls (based on discharges and days stay, adjusted for age, sex, and deaths). Roghmann, Sorensen, and Wells (1980) provide similar evidence. This certainly suggests that health status differences between PGP and other populations may lie behind the consistent inpatient utilization differentials.

Tessler and Mechanic (1975) did a telephone survey of persons who had recently been in a two-option situation and found that chronic conditions were more common among PGP enrollees. For other health status proxy indicators such as bed disability days and incidence of major illnesses there were no significant differences. However, benefit coverage again varied between the two plans in that the control plan contained a major-risk feature. It is not surprising, then, that chronicity was a characteristic of the PGP population.[48] Berki et al. (1977, 1978) found no significant health status differences between PGP and

48 Also, the significance of the difference in prevalence of chronic conditions among respondents seems to depend on the statistical technique used (Tessler and Mechanic 1975, 159), and differences in the same direction for spouses and children were evident only for low-income families.

BC-BS subscribers, despite significant differences in ambulatory benefit coverage.[49] Budenstein and Hennelly (1980) analysed families of new PGP members, and found no health status differences between those families which did and did not join the PGP.

In his comparison of PGP members with those with and without other private health care coverage, Blumberg (1980, 649) found 'that the percents of those with limitations on activity due to chronic conditions, and of those whose self-appraised health status was "fair" or "poor," were slightly higher among PGP members than among those with other private coverage.' Yet the hospital episode rate, excluding obstetrics' was 18 per cent lower for the PGP members.

Angermeier (1976) provides evidence suggesting that PGPs report lower hospital utilization rates because they provide care mainly to employee groups. The costs and utilization for non-group subscribers who took advantage of an open enrolment provision were significantly higher than those for group subscribers to the same plan. However it would be extremely risky to generalize these results since evidence suggests that the two groups were motivated to join the PGP by different factors. While it might be argued that any self-selection bias affecting the composition of the prepaid population would be equally common among group and non-group enrollees, in fact 98 per cent of employee group members who were offered the choice opted for the prepayment arrangement (Broida et al. 1975). It is quite conceivable that self-selection based on the risk-vulnerability concept (Berki et al. 1977, 1978) was a far more important factor in determining the non-group enrollee composition than it was for the group members. Berki and Ashcraft (1980) review in detail the reasons for people choosing to join HMOs and the evidence on the role of health status differences in the enrolment choice. A short discussion of the risk-vulnerability literature may be found in Wolinsky (1980).

A subset of the population that allows a better test of the 'health status difference' hypothesis is the Medicaid population in the United States. This group is not financially at risk for health care services in or out of a PGP, so that differential benefit coverage cannot interact with health status to affect enrolment choice. In a study that included eight PGPs, Gaus et al. (1976) found 'no significant difference between the study groups and their controls in terms of health status perceived or number of chronic conditions' (p. 7). Yet significant hospital utilization differences were found. Johnson and Azevedo (1979) also dismiss the health status explanation, noting for their study that 'among the criteria for originally selecting low income persons for [Kaiser] health plan

49 In the second study (1978) the number of chronic conditions per family member was found to be a significant factor favouring choice of a medical care foundation HMO but not of a PGP.

membership were: families with serious health problems having no medical care resources; and families with members between 45 and 64 years of age who had particular health problems. Also the matching process for selecting Medicaid recipients excluded persons with substantial morbidity, the blind and the disabled, while such persons were not excluded among the low income [Kaiser plan] enrollees' (965).

Perhaps the ultimate test of the importance of health status in explaining the hospital utilization differentials is exemplified in a study by Fuller et al. (1977). They compared the utilization experience of a given Medicaid sample before and after enrolment in a PGP. If we can assume that a person's health status will not change significantly over a period of forty-four months or that the changes of the whole sample will balance out,[50] then we have a study in which the two samples were almost perfectly matched in terms of health status. Again the hospital admission differentials persist.

In short, while health status is undoubtedly a major determinant of aggregate hospital utilization in Canada and the United States, the available evidence suggests that health status differences between PGP and non-PGP matched populations are not significant or, where they do exist, are not independently responsible for the utilization differentials. Where health status differences were reported they usually derived from variations in benefit coverage between plans, and the lower health status was commonly found within the PGP group. Yet, that would lead us to expect higher hospitalization rates among the PGP subscribers.

Before looking at the range of benefit coverage in more detail as a potential cause, we dispense with one other 'variable' briefly mentioned earlier – patient attitudes towards and awareness of illness. Again this is likely to affect aggregate hospitalization, but there is no evidence to suggest that attitudes and awareness differed between matched comparison samples. Densen et al. (1960) and Anderson and Sheatsley (1959) found no evidence of this type of selection bias. More recently, Berki et al. (1977) suggested that 'health concern' was a factor more characteristic of PGP enrollees than of BC-BS subscribers, but in a subsequent multivariate analysis (Berki et al. 1978), this variable was shown to be insignificant as a factor underlying the choice between PGP and BC-BS. Therefore this factor too is set aside as having at most a minimal influence on the utilization experiences of the matched populations.

The range and degree of benefit coverage provided by a subscriber's insurance plan or, equivalently, the degree of financial risk borne by the subscriber may influence hospital utilization in two ways. The range of insured hospital

50 If anything, since the sample will grow older we would expect a slight deterioration of the sample's health status. In fact, that strengthens the case for health status playing an insignificant role.

services may affect the extent of hospital utilization because of moral hazard.[51] But in addition the extent of ambulatory coverage may influence a patient's use of in-hospital facilities. Is either of these factors a likely determinant of the consistent inpatient admissions 'advantage' of PGPs and CHCs reported in the studies reviewed?

In the great majority of the PGP/non-PGP settings reviewed, in-hospital coverage was closely matched. Canadians have been beneficiaries of universal hospital insurance for nearly two decades, and BC-BS in the United States covers a large share of hospital care (see, for example, Berki et al. 1977, 101). In the HIP studies, both groups were covered for hospital care by Blue Cross. A study-by-study summary of in-hospital benefit coverage would add little to the argument, since in many of the studies (such as those in Canada and the HIP studies) in-hospital coverage was identical while significant utilization differentials were reported. The ambulatory factor, however, merits more attention.

The argument is made, and it seems a reasonable argument, that PGPs report less hospital utilization than control groups because they generally offer broader and deeper ambulatory coverage. Tessler and Mechanic (1975) found that the more comprehensive PGP benefit coverage was an important reason offered by those selecting these groups. When ambulatory coverage is limited, there is a financial incentive to hospitalize if substitution is possible. Of course, as Monsma (1970) points out, the other side of the coin is that PGP physicians have no more incentive to provide ambulatory services than they have to hospitalize patients. The only difference is that hospital services tend to be considerably more expensive than ambulatory services to the PGP. Many of the studies cited emphasized the differences in ambulatory benefit coverage between the matched populations (see, for example, Wersinger et al. 1976, Hetherington et al. 1975, Berki et al., 1977) and reported higher rates of ambulatory servicing along with lower inpatient utilization for PGP subscribers. Perkoff et al. (1974, 1976) and Hetherington et al. (1975) are just three examples in which ambulatory coverage was reported to be more extensive in PGPs and in which the authors found greater utilization of ambulatory services and lower hospitalization rates for PGP enrollees. Luft (1978b) reviews the evidence of the use of preventive services (only one segment of ambulatory care) and concludes that reports of greater use among PGP subscribers may be attributed directly to more extensive coverage for those services in PGPs. Theoretically the consumption of preventive services would vary inversely with hospital utilization, so this too supports the contention that 'ambulatory benefit coverage differences' are an important factor underlying the differential hospital experiences.

51 Reference is of course to the American setting and the studies originating there. By 'moral hazard' is meant increased utilization resulting directly from increased benefit coverage.

There is enough contrary evidence, however, to suggest that different degrees of ambulatory coverage may not be a crucial factor after all. Anderson and Sheatsley (1959) and Densen et al. (1960) compared populations with similar coverage; yet the utilization differences persisted. Lewis and Keairnes (1970) and Hill and Veney (1970) reported an experiment in which additional out-of-hospital service coverage was provided to a population of Blue Cross subscribers, with no concomitant change in hospital utilization patterns, but a surprising 38 per cent increase in surgical admissions for single subscribers. Broida et al. (1975) did a similar study in which the independent impact of prepayment on utilization was tested. This was not a matched population PGP vs non-PGP study. It compared the utilization experiences of two groups of persons receiving care from the same collection of salaried physicians. No information is provided on comparability of health status or socioeconomic characteristics within the two populations. The authors claim that the only significant difference resulted from the fact that one group prepaid for care while members of the other group were liable for direct charges for most ambulatory care. In effect, of course, this comparison is nothing more than that between two groups with different degrees of benefit coverage, and the study design is comparable to the situation discussed above in which ambulatory coverage was extended (Lewis and Keairnes 1970, Hill and Veney 1970). As the theory predicted, ambulatory visits were significantly more frequent among the prepaid population. But like the Lewis-Keairnes and Hill-Veney experiment, hospital discharge rates were not lower for the prepaid group. In fact they were significantly higher!

What is surprising about this experiment is not the results themselves, but the authors' explanation of them. They suggest that the finding of higher in-hospital service rates for the prepaid population runs 'counter to the conventional wisdom so far as the impact of prepayment on use of medical-care services is concerned' (Broida et al. 1975, 782). Apparently lower rates were expected for that group. Since in-hospital benefit coverage did not change and since both groups were receiving care from an identical set of providers who were on salary, it is not clear why they expected that. Perhaps one of the reasons offered by the authors to explain their results – increased detection of conditions requiring hospitalization as a result of the increased use of ambulatory services – is at least partly responsible for the results and should in fact have constituted part of their a priori hypothesis.[52]

52 It would appear that Broida et al. (1975) have confused their comparison with the more common PGP versus solo fee-for-service practice comparisons. Yet one of the crucial differences between those two settings – method of physician remuneration – is held constant in this particular study. The *same set* of salaried physicians administered care to the prepayment and fee-for-service populations: this confusion (if it is one) is not restricted to the original authors. Schroeder (1978) and Wersinger et al. (1976) fail to place this study in its proper context. The

Roemer (1958), who did a study of four types of coverage in Saskatchewan, also found that the extent of ambulatory coverage varied with the rate of hospitalization. He suggested that increased physician contacts arising from the extended benefit coverage were at least partially responsible for the hospital utilization statistics.

It was noted above that Roemer et al. (1972) and Hetherington et al. (1975) reported more 'high health risk' persons in the PGPs (where ambulatory coverage was more extensive) than in the matched populations. On theoretical grounds one would then expect, other things being equal, higher hospitalization within the PGP population. If one believed that disparate degrees of ambulatory coverage were responsible for hospital utilization differentials because of the perverse incentives to hospitalize where that coverage was more restricted, then one ought to believe also that the population health status differences resulting from those coverage discrepancies would tend to eliminate some portion of the utilization differentials. Yet, as shown in Table 4, the percentage differences in admission rates reported by Hetherington et al. (1975) are among the highest in the studies reviewed.

The evidence apparently refuting the importance of ambulatory coverage does not end there. Gaus et al. (1976) found no significant differences in overall ambulatory utilization in settings with identical ambulatory benefit coverage for the PGP and control groups. As mentioned above, however, they found six instances of significantly lower admission rates for the PGPs (the other two were also lower, but not significantly so). The study by Fuller et al. (1977) of the utilization experiences of a Medicaid population before and during PGP membership gave similar results. Benefit coverage for all care was effectively identical during the two periods of analysis. Yet both admission and ambulatory physician encounter rates decreased during the time of PGP enrolment. Williams et al. (1979) found fewer inpatient admissions among enrollees in an independent practice plan involving private practitioners, despite prepayment in both plans.

Finally, the Canadian evidence, in which the utilization differentials persist under uniform coverage, suggests a minimal role for the ambulatory benefit coverage variable. In short, it appears that 'merely extending insured ambulatory service benefits will not reduce hospital utilization under fee-for-service practice' (Roemer and Shonick 1973, 290) or under any other mode of provider payment. Furthermore, the hospital utilization differentials persist in settings with identical coverage of all types.

former suggests that 'despite isolated reports to the contrary, such as that of Broida (1975, 177) I have no doubt that hospitalization is markedly less in established prepaid group practices than in group or solo fee-for-service practice.'

So far we have eliminated health status and financial risk factors from serious consideration. Closely related to (and interrelated with) these variables is the set of socioeconomic status proxies. There is evidence that marital and family status and other such factors influence the rate of hospital utilization. For given age levels and insurance coverage, for example, single, widowed, and divorced persons tend to use hospitals more often than married couples.[53] Those choosing HMOs are more likely to be married (Berki and Ashcraft 1980), 'with larger and younger families than those choosing less comprehensive ... service benefit plans' (606-7), although contrary evidence does exist (Tessler and Mechanic 1975). The latter study also found a greater propensity for better-educated persons to join PGPs, while Hetherington et al. (1975) found that the correlation between education and hospitalization varied within PGPs: in the Kaiser plan the more highly educated consumers did use hospitals more, but in the 'small' PGP, the reverse was true.

Berki et al. (1977) reported significant differences between those who enrol in HMO-type plans and BC-BS subscribers on a number of socioeconomic variables. Again, HMO enrollees tended to be married and better educated. They also found differences in age, sex, and income, but the matched population studies usually standardized for those factors as far as possible. Roemer and Shonick (1973) and Berki and Ashcraft (1980) review additional information on socioeconomic composition of subscriber groups. There is, however, a distinct difference between talking in general terms about the socioeconomic composition of persons joining different groups and specifying the role of socioeconomic factors in creating the hospital utilization differences.

Perhaps the most pertinent test of the importance of socioeconomic factors in explaining hospitalization differentials is provided by those studies that focus on the Medicaid population and also standardize for age and sex. Gaus et al. (1976) constructed random samples of Medicaid patients stratified by age of household head, family size, and Medicaid program. The comparison populations were also closely matched in terms of sex and race and often ethnicity as well. If such factors were believed to lie behind the differences in admission rates, those differences would be expected to disappear in this study setting. In fact, as noted earlier, the significantly lower rates for the PGPs remained. Of course, the best socioeconomic matching is again provided by Fuller et al. (1977), who observed the experiences of one set of Medicaid beneficiaries before and after PGP enrolment. Again the significant differential, in the same direction, persisted.

Accessibility of medical care is almost certainly another determinant of aggregate hospital use. The availability of sources of primary care will affect

53 See Roemer and Shain (1959, 9-11) for a somewhat dated review of this evidence.

ambulatory care contacts for any given population, and that in turn might be expected to influence inpatient admissions.[54]

The evidence, such as it is, suggests no significant role for access to primary care. Salkever et al. (1976) addressed this issue by using the probability of receiving care for a variety of conditions as an access proxy. They found no significant differences in probability for adults, but a greater tendency for children of HMO subscribers to contact their primary care source for comparable episodes of illness. Similar results are reported by Berkanovic et al. (1975), based not on probability of receipt of care but on patients' satisfaction with their access to primary providers. However, the HMO side of the comparison was a medical care foundation rather than a PGP.

A series of studies assessing the factors underlying consumer choice of primary care delivery mode (Berki et al. 1977, Ashcraft et al. 1978) found that inadequate prior access was a major reason cited by PGP subscribers for their decision to enrol in the group practice. Prior access, as 'measured by the existence of a relationship with a private physician' (Berki et al. 1978) was inversely related to the propensity to join a closed-panel HMO. Ashcraft reported, furthermore, that those who did join an HMO because of 'lack of access to and dissatisfaction with previous sources of care' (14) were, to a large extent, satisfied with the access aspect of the HMO. This and other related literature is reviewed by Berki and Ashcraft (1980).

Finally, the Medicaid studies by Gaus et al. (1976, 11-13) and Fuller et al. (1977) are again useful sources of evidence. The former study measured access 'in terms of the time it took to reach a physician ... the percent able to do so, the time it took to make an appointment and waiting time in the office.' The evidence there seemed to favour the HMOs. Fuller's (1977) results were even more favourable to the PGPs. Enrollees waited fewer days for an appointment and spent less time waiting in the office. Furthermore, '67 per cent of the survey study group thought it was easier to see a PGP doctor than it had been to see a doctor through Medicaid. Only seven per cent thought it was more difficult' (ibid., 727).

This evidence is consistent with the argument that the utilization of ambulatory services is greater for PGP enrollees, an argument that has already been considered above. However, it does not provide any independent explanation for the lower hospital utilization rates of PGP subscribers.

If there is any consensus deriving from this discussion of the influence of patient 'characteristics' on the hospital utilization differentials, it seems to be that such influence is minimal. We look next at the providers of care.

54 There are two kinds of access – physical and financial. But financial access has been discussed in the guise of benefit coverage. The focus here is on convenience, on the indirect price aspects of accessibility.

Physician factors

That the more physicians there are in an area the higher aggregate hospital admissions will be in that area seems probable and is widely acknowledged to be true. But to argue that the number of physicians per capita is responsible for the admission rate differentials demands evidence on both the effect of physician / population rates on admissions and the comparative ratios for matched populations. One might for example suggest that the PGPs are characterized by lower physician/population ratios and that admissions per capita are lower in those settings for that reason. But it is difficult to separate that argument from the question of patient access, since a lower physician/population ratio may make it harder to get an appointment with a physician. If anything, access seems easier in PGPs. But how else could physician supply affect hospitalization differentials directly if not through access? Of course this begs the important question, since the evidence reviewed above did not suggest that the numbers of physicians serving each of two (or more) subscriber groups in a given study were significantly different.[55]

An important physician factor may be the hospital admitting privileges of the provider populations. If PGP physicians are denied equal access to inpatient facilities for any reason (such as professional opposition to the PGPs), this fact might be reflected in the groups' admission rates. Critics of the early HIP studies maintained that HIP-affiliated physicians were discriminated against when it came to receiving admitting privileges in New York hospitals and claimed that this explained the lower admission rates for HIP enrollees. Densen et al. (1960), who addressed that criticism, reported that 80 per cent of the HIP general practitioners were affiliated with at least one municipal hospital, a rate considerably higher than the 44 per cent for all family physicians in the New York City area. However, Klarman (1963) points out that statistics on specialists would have been more illuminating because they do most of the admitting, and that affiliation cannot be equated with access.

55 A likely reason for the absence of any such discussion is the difficulty of identifying the number of suppliers for a given population. The physical confines of the PGP pose no problem: counting heads does not require abnormal dexterity. But identifying the set of possible out-of-group physicians to whom group subscribers might be referred is more difficult. Within the control groups, one can adopt one of two methods: (i) Count the physicians contacted by members of the control. That may ignore some physicians who are the primary source of care only for a subset of the population who had no physician contacts during the study period as well as other physicians who might receive control group referrals but did not during the study period; (ii) Define a 'catchment area' based on some reasonable distance beyond which patients in the control would not travel, and count the physicians in it. But if that method is adopted it should apply to the PGP subscribers in a geographically matched study because theoretically they could be referred to any physician within that area or could choose to seek care outside the group.

The debate did not end there,[56] but none of the other studies reviewed here reported restricted hospital access for PGP physicians. Furthermore, as time has passed, the PGPs have been less and less overtly opposed by the profession and any such restrictions could be expected to have been correspondingly reduced. Yet recent studies report differentials at least equal to those of the HIP comparisons.

The arguments linking disparate quality of care to incidence of admissions are hard to assess because of the difficulty of quantifying quality. If one equates high-quality care with an emphasis on prevention and early detection, then two opposing causal chains are possible. Stressing early detection or prevention in one setting might allow early cures of conditions that would otherwise eventually require hospitalization; or, equally convincingly, more intensive screening might allow detection of more conditions requiring earlier hospitalization. Before either argument is tested, however, one must be convinced that this type of preventive activity is an useful quality indicator by which to compare delivery systems.

Luft (1978b, 1980a) and Roemer and Shonick (1973) have reviewed the evidence on provision of preventive services. There seems to be no clear consensus that PGPs provide more such services than their fee-for-service counterparts, or even if they do, that all such services are efficacious.

But there is surely more to quality of care than prevention. Overall changes in health status are what should be of interest, and, as is common when dealing with that topic, there is little evidence to draw on. Hetherington et al. (1975) assess the variations in three other quality proxies: rationality (which refers to the thoroughness of the care process in response to a presented complaint, and is constructed from indicators that include physical examination, history, and diagnosis); verification (referring to diagnostic followup and including blood count, urinalysis, serology, and chest x-ray); and continuity (followup visits). They found that the two PGPs (which had ranked first and second among the six plans on the prevention indicator) ranked first and third for rationality, first and second for verification, and third and fifth on continuity. The PGPs were first and second in overall quality of care. The authors suggest that 'ongoing peer review and opportunities for continuing medical education' (ibid., 180) may be important physician factors underlying this evidence, but there is also some suggestion that, particularly concerning verification and prevention, the PGPs overprovide or misdirect services (ibid., 193-4).

This particular evidence is inconclusive but does not suggest that the lower hospitalization rates for the PGPs are the result of lower-quality care in those

56 Those interested in following the progress of the debate might have a look at Klarman (1969) and Shapiro (1970).

settings. An older series of studies using prematurity and perinatal mortality rates as health status measures suggested higher quality of care in HIP than in its controls (Shapiro et al. 1958, 1960), and Miller et al. (1967, 203-6, Appendix IV) highly commended the quality of care found in Kaiser Plan groups.

Dutton and Silber (1980) reported generally poorer than expected children's health outcomes in solo practice, and higher than expected outcomes in a prepaid group. Expectations were based on demographic factors, previous illness and health care utilization history, and family age/sex structure and socioeconomic status, and were related to five relatively common children's conditions. In attempting to explain their results, the authors noted that 'doctors in the prepaid group ... were more highly trained than the solo practitioners – almost twice as many had completed pediatric residencies [and] ... prepaid group ... physicians also had more postgraduate training and were more likely to have attended medical schools regarded as high quality' (708). Also, almost half the solo physicians 'had a second medical practice in addition to their primary practice ... [while] less than a quarter of the prepaid group ... physicians listed a second practice (and those who did usually were referring to care of hospitalized patients)' (ibid.).

Cohen (1980) compared utilization rates for a single procedure – 'prenatal cytogenetic diagnosis (a medically indicated service for women aged 35 and older)' (513), and found the rates in four PGPs to be equal to, or higher than, in their respective comparison communities. This technology is generally agreed to be 'medically indicated for a defined and identifiable segment of the population' (516), and access could be eliminated as a potential explanation of the disparate rates.

Finally, the lack of contrary evidence itself suggests that quality of care is at least as good in prepaid group practices and community health centres as in alternative settings.[57]

The final and perhaps most important physician factor to be considered here is the method of paying the provider.[58] It pervades the literature reviewed in this

57 Roemer and Shonick (1973), Cunningham and Williamson (1980), and Wolinsky (1980) review some further studies relating to quality. One exception appears to be the recent formation in California of prepaid plans that provide care for the Medicaid recipients of that state, where fraudulent practices and low-quality care apparently went together. 'The change in political climate after 1970 and the relatively sudden potential, particularly in California, for making large profits off government contracts and grants have brought into the field people with rather different motivations' (Starr 1976, 81). But this experience, suggests Schroeder (1978), was an exception rather than the 'rule' and was perhaps the direct result of allowing proprietary interests rather than consumer interests to control many of the groups.

58 Not that there are no other 'physician factors.' Years of practice, age, sex, education, and medical philosophy may influence a physician's propensity to hospitalize his patients. But relevant evidence on differences of this type across matched-population provider groups

chapter as a basic difference between the PGP and control organizations. The intent here is not to become submerged in the voluminous literature on methods of physician remuneration, for that would be neither novel nor particularly useful.[59]

The many discussions of this subject pertain almost exclusively to four alternative schemes: fee-for-service, capitation (per patient), salary, and, less commonly, case payment (a fixed amount for care of an entire episode of illness). Not all of the related literature makes the distinction between payment to the medical practice and payment to the physician as an input to that practice.[60]

Most of the utilization studies reviewed in this chapter compared fee-for-service health care delivery with one or more of the remaining schemes. But in what form was this comparison manifested? If we think of a physician in a private practice as an entrepreneur who pays himself an implicit wage in return for his time, then as far as payment for work is concerned, there is no economic difference between private practice and an organization in which a doctor is paid a salary, regardless of how the organization is reimbursed. Thus, the distinction is not between methods of physician remuneration for practice time, but between methods of profit or of income-sharing. The private practitioner receives practice profits net of expenses including his shadow wage, and that is what distinguishes him from his salaried counterpart. In effect, then, the comparisons noted above were often between physicians who received essentially only an explicit wage (i.e. a salary) and those who had a major vested interest in practice profits.

seems not to have been gathered. If the mix of providers serving PGPs was markedly different from the general mix in terms of the first four factors, one would be inclined to conclude that it was not years of practice or age, say, that was responsible, but rather the different medical philosophies adopted by those physicians. For example, younger physicians who had recently graduated might be more receptive to working in the comprehensive care environment of PGPs. This would seem to suggest that only medical philosophy needs to be dealt with. Unfortunately no one yet knows how to quantify it. To the extent that philosophy is reflected in a physician's choice of method of payment, it is dealt with here. Medical philosophy is also inseparable from the general 'organizational factors' discussed below.

59 A full-scale discussion of methods of remuneration has been avoided because such analyses already abound. The subject is considered briefly in many volumes and articles such as Fraser 1975, Evans 1975b, Crichton 1973, Pauly 1970, Ontario Economic Council 1976, Migué and Belanger 1974, Shortell 1972, Foulkes 1973a, Roemer and Shain 1959, Somers and Somers 1961, and Pickering 1973. In addition, Glaser (1970, 1976), Boudreau and Rivard (1976), Roemer (1962), Gabel and Redisch (1979) and Hogarth (1963), for example, made this subject the principal focus of their research.

60 For a discussion of the consequences, see Evans (1975a, 1976a).

The physicians in the PGP/CHCs are usually paid a salary or according to a prearranged income-sharing plan.[61] In the United States the organizations themselves are financed on a capitation basis. In Canada, CHCs have functioned under global budgeting agreements with the relevant government agencies or have been reimbursed on a capitation basis. In contrast, BC-BS and commercial plans in the United States and plans such as OHIP in Canada reimburse private practices according to fee schedules, on a strictly fee-for-service basis.

The way in which the practice is reimbursed and the physician's role within the practice organization are potentially significant reasons for the differential use of hospitals because of the basic conflict of interest that faces a physician-entrepreneur in a private practice. As an entrepreneur his incentive is likely to be the maximization of net receipts (or a combination of net revenue, leisure, and some other mix of utility arguments). As a physician and provider of care to relatively uninformed consumers his aim ought to be to undertake whatever the patients' interests warrant, and no more. The combination of these incentives seems to favour throughput maximization of services that are both highly remunerative on a unit-of-time basis and of little or no risk (or possibly of help) to the patient. Such services may include hospital admissions for elective surgery, since the hospital provides inexpensive support services while elective surgical procedures tend to be of minimal risk (and often of little value) to health status.[62] In addition, necessary surgery that could be done on an outpatient basis is more likely to be treated in that manner by PGP physicians, and the HMO setting may encourage a substitution of ambulatory for inpatient diagnostic procedures since the HMO is often at risk for the hospital costs incurred by its patients.

The tenor of this discussion is quite strikingly supported by the data reviewed earlier. In addition, Monsma's (1970) seminal article on the relationship between demand and marginal revenue for physicians' services presented empirical evidence for his hypothesis that 'the demand for physicians' services is influenced by the marginal revenue physicians receive' (ibid., 145).

Further evidence supporting the importance of this factor has appeared in two analyses of an experiment in Baltimore. Although not strictly pertinent to hospital utilization, the evidence does concern the question of remuneration. In 1963 Baltimore's medicare program was having difficulty with a capitation

61 See Weil (1976, 345-6), who states that 'Physicians in ... prepaid groups are usually salaried ... All of the plans pay salaries to their full-time physicians. Salaries are often determined by the number of persons for which the particular group of physicians is responsible (capitation), but in the case of full-time staff, the income from prepayment is pooled and redistributed in a previously agreed-on manner.'

62 The interested reader might enjoy Williams's (1971b) piece on avoiding unecessary surgery.

system owing to the inequitable distribution of older persons across physicians' practices. The physicians who were caring for a relatively large proportion of these patients were being inadequately reimbursed for the extra services they were required to provide. In response, the program changed to fee-for-service early in 1963. Rodman (1965) and Alexander (1965), who analysed the resulting physician utilization data for the rest of 1963 and for 1964, concluded that, after the change in remuneration, there was a definite trend towards higher utilization of physician 'facilities.' Rodman suggested that the increase was in the order of 10 per cent for 1963 and predicted an even higher average increase for 1964.

Luft's (1978a) review of the PGP hospitalization literature suggests that PGP physicians do not admit patients simply for diagnosis and tests as often as their control counterparts. He finds less definitive evidence as regards surgery: 'people in HMOs have markedly lower surgical rates and ... prepaid group practices have very low rates for some specific 'discretionary' procedures. However the rates for non-surgical admissions tend to be equally low, and the 'discretionary' rates, with the exception of tonsillectomies, are not consistently lower than the rates for all surgical procedures' (1341).

Luke and Thomson (1980) standardized for the possible influence of hospital factors in looking at the effect of method of physician payment on use of hospital resources. Among other things, they compared lengths of stay in one hospital of patients of a prepaid group, a fee-for-service group, and a set of unaffiliated physicians. The prepaid group patients had the lowest diagnosis/severity-adjusted length of stay. Also interesting was their finding that the fee-for-service group showed the highest rate of consultations.

Evidence from the medical care foundation literature and from Broida et al. (1975) is also revealing. Foundations, which are ostensibly (and by definition) HMOs but whose physicians are reimbursed by fee-for-service, have provided little evidence of hospitalization differentials like those reported for PGPs, despite the financial incentive to the HMO to minimize the use of hospitals. Broida's comparison of a prepaid and a fee-for-service population each receiving care from salaried physicians failed to produce a hospitalization differential favouring the prepayment population. Finally, PGPs such as HIP, which was not at risk for the hospital utilization of its patients, report lower admission rates for their subscribers.

While this discussion does not allow the unequivocal conclusion that the method of physician remuneration is the causal link explaining these differences, that explanation is at least consistent both with a plausible conceptual framework and with the copious empirical evidence presented here. (See also Blumberg 1980). Moreover, if one is willing to accept this conclusion tentatively,

one must also be sympathetic to the suggestion that the PGP admission rate may be slightly upward-biased as a result of out-of-plan use by group subscribers. If non-PGP providers who render services to those subscribers are paid on a fee-for-service basis and hospitalize patients at rates representative of all fee-for-service physicians in their area, and if PGP hospitalization rates reflect the total hospital use of their subscribers, then those rates will be upward-biased estimates of PGP-physician-generated inpatient utilization.

While we are unable to eliminate physician admitting privileges from consideration definitively, the only physician factor of any consequence seems to be the method of physician reimbursement.

Hospital factors

That bed supply and internal hospital policy (as set by administrators, medical staff, and boards of trustees) have an impact on hospital utilization is unlikely to be disputed. However, aside from bed availability there is no indication that these factors would be discriminatory in their influence. In-house decision making with respect to patient care does not seem to be a function of the type of organization from which the patient sought primary care.

There is some evidence that the per capita supply of beds tends to influence utilization rates. Feldstein (1967) found evidence of an apparently insatiable demand for beds. Occupancy rates tended not to be a function of beds per capita. Roemer (1961a), reporting on an American county in which approximately two hundred additional beds were added in a community that had experienced a 78 per cent occupancy rate, found a sharp rise in number of admissions and ALS for the two subsequent years, a period when the population rose only marginally. In particular, while bed capacity increased by 42 per cent, Blue Cross subscribers increased hospital days in the first year by 38 per cent. On the other hand, Stevens (1970) argues that physician-generated demand for beds, originating with open-staff hospital policies that do not limit the number of physicians with admitting privileges, is the prime factor. The result is an increased bed supply followed by a corresponding increase in admissions. In either case, the supply of beds cannot be considered solely a 'hospital factor' since the physician is an important part of the linkage in both arguments.

Those who contend that bed supply differentials underly the utilization differentials undoubtedly base their argument on the Kaiser experience. While Kaiser group physicians practise within a presumably inflexible constraint of approximately two beds per 1000 subscribers, the American average is over four beds. It is not difficult to see how the lower Kaiser utilization rates could be explained easily by that one factor. But the explanation may be wrong. Kaiser owns its hospitals and is therefore at risk for the hospital and ambulatory care of

its enrollees. As noted earlier, HIP did not own hospitals and was not at risk fo
its patients' hospital use at the time of the studies reviewed earlier. Most of th
other research incorporated enough geographical standardization to eliminat
bed supply as a means of generating the differentials. For example, Wersinger e
al. (1976) compared three HMO-type settings that had equal access to hospita
beds and still found significantly lower admission rates for the PGP than for th
other HMOs or BC-BS. This finding suggests that while the Kaiser situation ma
impose lower admission rates by relative bed scarcity, such an imposed bec
supply differential is not necessary and may not be sufficient to reduce admis
sion rates.

Other 'hospital factors' suggest a similar conclusion. Hospital directive
about admission and discharge policy, the influence of the medical staff ir
determining operating policies in the hospital, and the way in which a hospital i
reimbursed, will all influence its occupancy rate. (For example, reimbursemen
on a per diem basis is likely to encourage a high occupancy rate). The availability
of alternative chronic care facilities in the neighbourhood will determine the
extent to which acute care beds must be filled by extended care patients.
Similarly, the availability and accessibility of other sources of ambulatory care
will influence hospital use. Bellin et al. (1969) report that the utilization of
nearby hospitals declined markedly in the two years following the opening of a
Boston neighbourhood health centre. And one cannot neglect ownership of the
hospital as a factor contributing to its utilization. But insofar as most Canadian
hospitals are in the public, non-profit domain, the means of payment to hospitals is usually more important than ownership. Reimbursement schemes such as global budgeting appear to have little effect on hospital utilization (Ontario Economic Council 1978); at any rate they are not important to the present discussion. While these factors may have interacted with different weights in the overall utilization process, none of them was so differentially pervasive in the matched populations that it could have been of more than minimal influence.

The hospital factors, then, do share a common characteristic: they all affect the extent of hospital utilization. They also seem alike in that none of them will influence consistently one population sub-group more or less than another.

Organizational factors

Densen et al. (1958) identified the difference in practice organization as one of three possible explanations for their results. We have since eliminated one of those – differential ambulatory coverage – and have kept one – physician remuneration. That leaves the organizational factor.

It may be argued that the interaction of a number of organizational factors peculiar to the PGP/CHC may reduce inpatient care. Perhaps peer review and

ready consultation, the availability of diagnostic facilities, and an emphasis on treating the patient rather than a series of episodes of illness could discourage hospitalization except where absolutely necessary. How legitimate is that argument?

For private practitioners, access to much of the necessary diagnostic equipment may be had through one of three channels: hospital facilities, referral to a specialist, or referral to a private medical laboratory. Referral to a specialist contains a certain amount of risk for a general practitioner, insofar as the patient may decide to continue being treated by the specialist. For patients who need radiological or laboratory tests, but not specialist consultation, a general practitioner must choose between private laboratories and hospitals. In some cases it may be more convenient for a physician to use a hospital and thus to cause some 'unnecessary' hospitalization. For example, a physician who suspects that a patient will have to be hospitalized but who wishes to have the patient's diagnosis confirmed by tests might choose to hospitalize the patient, do the tests there, and, if the condition is less serious than expected, release the patient. This method, costless for the physician, may also be more convenient for the patient.

Group practices and health clinics on the other hand provide some combination of laboratory, radiology, and therapeutic services to ambulatory patients without outside referral being necessary. This would appear to be a way of reducing some of the pressure on hospitals.

The extent to which hospitals are thus used by private practitioners when other arrangements would suffice is difficult to ascertain. How does one distinguish for example between primarily diagnostic admissions for upper respiratory ailments from admissions primarily for treatment? One way of judging how far physicians use hospitals in place of other diagnostic facilities would be by standardizing for organizational characteristics and noting whether the differentials persist. Wersinger et al. (1976, 723) compared 'a multiple-site group practice providing services on a fee-for-service and prepaid basis' with a PGP, but the network was not at risk for hospital care. While the PGP subscribers were admitted to hospital less often, that may have been a function of the different financial responsibilities of the two groups.

Scitovsky (1980) and Scitovsky and McCall (1980) found almost identical inpatient day rates per 1000 persons (excluding maternity) in comparing a PGP with a fee-for-service group practice whose physicians were not at risk for hospital use. While admissions were fewer among the PGP enrollees, average length of stay was higher. These settings differ from the PGP vs solo comparisons apparently only in the shift from solo to multi-specialty group as the basis of comparison. The disappearance of the differential does suggest an independent role for the form of organization in explaining hospital utilization differentials.

This appears to be one of the areas where the empirical literature has little to offer. Undoubtedly that is partly due to the vague 'formalizations' of organizational factors and their dimensions and to the conceptual difficulty of distinguishing practice style and philosophy from the entrepreneurial and financial risk aspects. Therefore, although there appears to be some role for 'practice organization and characteristics' in the hospital utilization differentials, the extent of that influence is uncertain.

Summary

We have considered in detail a wide range of factors likely to affect hospital utilization. We were unable to eliminate two factors potentially capable of explaining the hospital utilization differentials: whether the provider shares in practice profits, and practice organization. Although these variables may not be the most important in determining the absolute volume of admissions, they were the only distinguishing characteristics of all sets of comparison groups. In a discussion devoted to a similar investigation, Evans (1975b, 21) provides an apt conclusion:

> Klarman (1970) ... points out ... that the differences between fee-for-service and capitation or administered budget practices are much more complex than simply the difference in mode of practice or physician reimbursement. Organization and philosophy differ dramatically across modes, as presumably does the psychology of the participating physician. It is not rigorously proven, therefore, that the remarkably consistent reduction of hospital use of about 20%-25% which is associated with shifts away from fee-for-service is in fact a result of the removal of economic incentives to excess use. Nevertheless, on the basis of the existing evidence, it is clearly much more plausible than the null hypothesis.

Since payment of PGP physicians by salary and the organizational structure described earlier are integral characteristics of PGPs and CHCs, there is no reason to believe that the experiences reported in the literature could not be reproduced in similar situations in Ontario. In fact the Hastings et al. (1973a) and DeFriese (1975) evidence shows that in Ontario, as elsewhere, a CHC can reduce the use of hospitals.

CONCLUSION

This chapter has reviewed the literature comparing the hospital utilization of PGPs or CHCs with that of matched population control groups and analysed those studies to assess the general applicability of their results. As Table 4 shows, PGPs

with remarkable consistency reported admission rates 15 to 50 per cent lower than those of the controls. Differences in length of stay did not seem related to the mode of delivery.

The comparable Ontario experience was also reviewed, and the present conditions under which new CHCs would have to operate in Ontario were discussed. It was suggested that modifications to the 'free choice of provider' characteristic of Canadian medicare (universal insurance plan) will be necessary if the PGP or CHC concept is to regain any meaning in Ontario. One possibility would be to de-insure any services available through the CHC that enrollees chose to receive from non-CHC physicians.

Our assessment of the variables that may be able to explain the consistent admission rate differentials suggested that, where the providers were paid primarily by salary, the admission rates were lower than for patients of other kinds of practices. In addition, we were unable to eliminate organizational differences from consideration. All other potential influences were standardized in some part of the empirical literature in which the admission differentials persisted.

The estimation of hospital cost savings that will occupy the rest of this study should, then, generate figures which will be fairly representative of what we might expect on a broader scale, given comparable PGPs. Such estimates depend on the derivation of diagnosis-specific hospital expenditure figures that can be matched with utilization data from the literature described in this chapter. The next chapter develops the framework within which those cost estimates may be derived.

Summary of Chapters 3, 4, and 5

The next three chapters show how the diagnosis-specific marginal costs of inpatient hospitalization have been estimated. This summary will enable the non-specialist reader to grasp the main points, with which it is possible to skip directly to Chapter 6.

In order to convert the hospital utilization differences described in Chapter 2 to their equivalent hospital costs, we need information on the costs of treating those 'saved' cases or days of inpatient care. In short, it becomes a question of estimating the additional hospital costs that would have been incurred by the PGP or CHC enrollees, had their inpatient utilization patterns been identical to those of their control counterparts.

It is not enough simply to multiply provincial average hospital costs per day by the days 'saved' by PGP or CHC enrollees, because hospitals are involved in activities other than inpatient care. In addition, since some part of total hospital costs are fixed (i.e. are not functions of patient load) and will therefore be incurred by hospitals whether or not those CHC and PGP differentials materialize, the correct measures to be applied to the utilization differences are marginal costs rather than average costs. We want to know the cost savings possible through reducing hospital utilization 'at the margin,' while leaving the hospital infra-structure intact, as it would have to be barring much farther-reaching organizational changes. Finally, it is not enough to apply a single marginal cost figure to all days or cases saved, since the marginal cost of treating a patient will depend crucially on the illness. Consequently marginal costs are estimated for each of 237 distinct diagnoses.

Chapter 3 addresses the general method of estimation and its problems. A behavioural model of hospital costs is specified which simply tries to incorporate all the factors that could explain differences in the cost structure of various hospitals. Only inpatient care costs are isolated for this model.

Chapter 4 then sets out to explain the variation in those costs in our Ontario sample of 182 public acute-care hospitals. In particular, inpatient costs per case and per day are analysed by the use of such 'explanatory' variables as case flow rate (cases per bed per year); occupancy rate; non-inpatient-care activities such as education, research and outpatient functions; and the age, sex, and diagnostic mix of the patients treated by each hospital. We can then determine the relative importance of each variable in explaining the variation in costs between hospitals. But even more important, the estimated model is our best guess as to the cost structure of Ontario hospitals. With it we can estimate the effect of hypothetical changes in hospital characteristics (such as occupancy rate or case mix) on each hospital's inpatient costs. That is what Chapter 5 does.

To estimate the diagnosis-specific marginal costs, we change the values of certain explanatory variables and calculate the marginal effects of these changes on unit costs (costs per day or per case). For example, to compute the marginal cost per day for diagnostic category 142 – infections of the kidney – a hypothetical question is set: what would the effect on hospital X's marginal cost per day have been if it had treated five (or some other small number) fewer cases of type 142 in year *t*? To answer that question we changed the values of the explanatory variables in line with this five-case reduction (all else unchanged) and estimated a new average cost for the hospital. It was then easy to calculate the marginal cost for that diagnostic category by comparing the average costs for that hospital before and after the five-case reduction.

The results of this analysis are presented in Table 13. The diagnostic categories are listed in Table D.2 and SSMCC1 and SSMCD1 denote respectively marginal cost per case and per day assuming that bed stocks are not adjusted in response to the hypothetical reduced patient loads. The other two columns of Table 13, SSMCC2 and SSMCD2, represent the results of adjusting the number of beds at the same time to maintain a constant occupancy rate. As is evident there, the marginal 'savings' are uniformly higher when the bed supply is reduced than when it is not.

3

A model of hospital costs and the experience of Ontario hospitals, 1969-74

Having found in the previous chapter that the lower hospital utilization of PGP/CHC patients seems generalizable (that is, no unique features of the study settings were apparently responsible), we now proceed to convert those differences to dollar costs. To do this, we estimate marginal costs for each of 237 diagnoses both per discharge and per inpatient day. Using utilization differentials provided by four of the studies reviewed in Chapter 2, we then get a range of estimates of expenditure on excess hospital utilization by diagnostic group. Behavioural hospital cost equations specified in terms of discharges and days are developed and estimated in this chapter and the next. These equations include a measure of hospital case mix complexity as an explanatory variable. This variable is a weighted average of each hospital's case mix, the weights being diagnosis-specific complexity values.[1] The inclusion of this type of case mix variable in the average cost equations enables us to estimate the changes in average cost resulting from marginal changes in case mix. If only one diagnostic category from that mix is altered, marginal cost estimates for that case type can be obtained.

An extensive review of the literature on hospital cost equation estimation is not offered here. There are a number of such reviews, and repetition here would add little to the subsequent analysis.[2] However, some common problems of hospital cost analysis are discussed. Familiarity with the main problems encountered in previous exercises of this nature will make it easier to understand the measures taken to avoid some of them here.

1 A number of alternative case complexity measures were constructed and tested empirically. They are described in Appendix B. Appendix A contains a description of the main case mix variable employed in our analysis.

2 See, for example, Lave (1966), Mann and Yett (1968), Berki (1972), Migué and Belanger (1974, Ch. 2), Jenkins (1974), and more recently Barer and Evans (1980), Barer (1981), Lipscomb et al. (1978), and Hardwick (1981).

Perhaps the most widely recognized difficulty in estimating cost equations for the hospital care 'industry' is caused by its multi-product nature. This makes specification of output – the unit of observation over which costs are to be compared – of paramount importance in the articulation of any model. While the sum of changes in patients' health status between admission and discharge might seem a suitable measure, its use would assume that the hospital care received was the sole determinant of any such change. That, of course, is an unrealistic simplification and has interesting consequences if applied to patients who are terminally ill when they are admitted and who die in hospital. Furthermore, while significant recent advances have been made in developing operational health status measures (such as by Torrance 1976a, Culyer 1976, 1978, Wolfson 1974, and Berg 1973), they are not yet ready to be applied on a broad scale to measure hospital output. In addition, certain hospital activities have objectives other than short-run improvements in patient health status. Education and research may in the long run raise the standard of community health, but it would be difficult to measure their output in terms of health status changes.

Accordingly a variety of output proxies are used. One could abstract from non-patient care activities and concentrate on measuring the costs and outputs of the remaining hospital functions. Or one could narrow the focus still further to address the dominant activity – inpatient care. The various options and methods of standardizing for this activity mix and the problems and assumptions implicit in each are described elsewhere (Barer and Evans 1980). Two broad approaches are identified in the context of hospital cost analyses: 'left-side' standardization, in which 'total costs' contain only the costs incurred in producing the chosen unit of output (i.e. only inpatient care costs where the output measure is discharges or days); and 'right-side' standardization, which includes independent variables to represent the extent of all activities not incorporated in that unit of output (i.e. variables for education, research, outpatient care, etc. when days or discharges is employed).

Regardless of which method of activity standardization is adopted, however, the choice of an output measure remains. In this analysis, a 'left-side' standardization approach is used, and only the costs of inpatient care are compared. Measures of inpatient care output that might be used are patient days, episodes of illness requiring hospitalization, admissions, and discharges. As noted above, this analysis adopts two of those variables: patient days and separations.[3] The

3 Feldstein (1967, 24-5) discusses the advantages of using cases as opposed to days (or weeks) stay, prior to case-mix adjustment. Using days as an output measure tends to penalize hospitals that try to concentrate nursing or medical costs into a shorter time in order to reduce

method of activity standardization used here is detailed below.[4] Even after the choices of activity and output measures for that activity have been made, a second dimension of output heterogeneity remains. Days and discharges can each mean different things. A hospital that ranks first among all hospitals in total days of inpatient care provided may find itself far down the list when admissions or discharges are measured. In what sense, then, is it legitimate to estimate short- or long-run average cost curves that relate capacity or output to average cost per unit? Costs will vary dramatically according to mix of cases, severity of cases, costs of inputs and quality of care. Again there are two general approaches to standardizing for inter-hospital and inter-temporal case mix variation: left-side and right-side standardization. The left-side approach consists of weighting the output measure (the denominator of the dependent variable in the average cost equation) by relative diagnostic complexities and in that way constructing a dependent variable defined as the average cost per standardized (for complexity) unit of output. The right-side approach is to incorporate case mix information explicitly into the right side of the equation by including one or more hospital case mix independent variables. The present analysis uses the right-side method. The advantages of that choice and the assumptions implicit in either option are covered in detail in Barer (1981).

The penalties for not standardizing for case mix are fairly obvious. Consider discharges for example. A simple summation, implying equal weight to each diagnostic type, results in the assumption (in the extreme) that the discharge of a tonsillectomy patient and the three-month stay of a patient suffering from a malignant carcinoma are equivalent output units. Even if treatment costs were roughly equal (and they obviously are not), the differences in total 'accommodation' costs for different lengths of stay make unadjusted cases analytically useless. Unstandardized patient days are no more tenable as a measure of hospital output. The supposition that accommodation costs (food, laundry, linen, and so on) vary directly with days of stay may not be unrealistic. However,

length of stay, and thus case costs. The use of cases as a measure of output, even with case-mix standardization, is biased by duplicate admissions (the same patient being readmitted for the same episode of illness) or transfers between hospitals. This will reduce per case costs, and, more important, the bias may be confined to, or concentrated within, certain diagnostic categories, making relative comparisons across cases somewhat suspect.

4 In particular, while we do apply left-side standardization, we retain a number of right-side activity variables to test for secondary effects. The next section elaborates on the reason for including them. The process of left-side standardization is in effect a cost allocation exercise applied to the numerator of our dependent variables.

extending this assumption of direct variance to treatment costs implies that a recuperation day after the tonsillectomy costs as much as a day spent in the operating room undergoing major surgery.

The literature reveals many approaches to case mix standardization in hospital cost analyses. Among the researchers who use variants of right-side standardization have been Feldstein (1967) (using proportions of cases falling into various specialties and then principal components based on those groupings); Evans (1971) (proportions of cases within forty-one diagnostic categories and forty age-sex categories, and then factor scores based on those); Goodisman and Trompeter (1979) (similar to Evans (1971), without the age-sex data); Evans and Walker (1972) (factor scores again, and then complexity measures based on information theory); Jeffers and Siebert (1974) (conceptualizing changes in case proportions as determinants of cost differentials); Lave and Lave (1978) (proportions of cases within seventeen broad ICDA groups as well as proportions of patients receiving complex and simple surgery, and then principal components and variants based on those groupings); Lee and Wallace (1973) (proportions of cases falling into categories defined over 'duration and extent of disability' (356), and then categories based on the ICDA); Horn and Schumacher (1979) (information theory measures based on 'Diagnosis Related Groups' (see Fetter et al. 1980); and Schumacher et al. (1979), Hardwick (1981), and Barer (1977, 1981) (complexity measures based on information theory). Barer (1981) and Klastorin and Watts (1980) review in detail the case mix standardization approaches adopted by these and other studies,[5] and Watts and Klastorin (1980) compare the explanatory powers of many of these approaches.

Right-side standardization techniques have a few common themes. One basic method aggregates cases into some specified grouping of diagnostic categories, computes the proportion of total cases falling within each category, and uses the

5 There have been two other general approaches. The first tries to 'standardize' by grouping hospitals according to the services and facilities they offer. Attempts to stratify hospitals according to their service mix (range of available services and facilities) and to estimate separate equations for each hospital grouping are based on the assumption that hospitals offering similar services and facilities produce relatively homogeneous outputs. While this may be one step better than no standardization, it also requires us to accept service and facility mix as valid proxies for case mix. This neglects not only the possibility that similar capacity may be differently deployed in different settings but also the fact that some hospitals may contain varying degrees of excess, underutilized, capacity. For a description of other similar approaches, see Berki (1972, 87-97) and Barer (1981). The second method, applicable only to time series analyses and used by Lave and Lave (1970a, 1970b, 1971, 1978), builds in the assumption that over short periods the case mix in a single hospital is relatively constant. Barer (1981) provides evidence suggesting that this assumption may be unrealistic.

resulting proportions as independent variables in an average cost per case equation. This method has two important shortcomings. Unless one has access to a large cross-section of hospitals, the model can impose severe restrictions on degrees of freedom if sufficient case-type-disaggregation is to be captured. In addition, serious collinearity problems among the proportions can be expected.[6]

A reduction in the number of independent variables may, in itself, take many forms. The simplest, and least satisfactory, is to increase the level of aggregation so as to decrease the number of diagnostic categories. Anything gained through aggregation will probably be lost through the reintroduction of heterogeneity within categories. A second approach uses principal components or factor analysis, by which the number of variables is reduced while the greater part of the variance in the original vectors is retained.[7]

Further reduction in the number of independent variables needed to capture the variance in case mix is possible through the use of information theory. That method is one of two adopted in the present analysis: the other is an application of the standard gamble technique. The information theory approach is used throughout this analysis since the significance of the variables based on that construction was greater in all cases than that of similar variables based on standard gamble case complexities.[8] Information theory is also used to derive a measure of specialization for each hospital, and the age-sex mix of each hospital is incorporated through the inclusion of factor scores based on forty-four age-sex categories.

The application of information theory (or any other method for that matter) to the construction of relative diagnostic complexities that can subsequently be used as weights in aggregating a hospital's case mix avoids the problem of overburdened equations while at the same time allowing the retention of the diagnostic information inherent in any level of disaggregation.

Output definition and standardization seem to be the main issues of contention in this type of analysis. But they are not the only ones. The incorporation of variables to represent variation in quality of care is desirable but rarely practised. The assumption implicit in this analysis is that all hospitals provide care of

6 This was the experience of Evans (1971), Lave and Lave (1978), and Goodisman and Trompeter (1979).

7 A more detailed look at principal components analysis appears in Appendix A, where the derivation of age-sex factor scores from the age-sex distribution of hospital discharges is described.

8 As a result, and to streamline the text of this chapter, the standard gamble approach is described in Appendix B.

equal quality or that variation in quality is correlated with that of other independent variables such as hospital specialization, complexity, and extent of educational activity. The remaining methodological considerations are the appropriate measure of scale (or size or capacity) of hospital operation and the interpretation of, or underlying micro-foundations for, cost curves as developed in the ensuing discussion. Turning first to the question of measure of scale, one finds an excellent discussion of the relative merits and shortcomings (more of the latter than of the former) of measures such as beds, bed days, bed complements, and patient days in Berki (1972, 100-14). The crux of the issue, however, is that capacity is meaningful only if specified in terms of the relevant output and the associated binding production constraints; in the case of a multi-product 'firm' such as the hospital no single measure can capture all constraints. For example, subsets of total bed capacity are often not interchangeable across service areas (and thus across case types) and if a 200-bed hospital is staffed for only 160 beds, the binding output constraint is not the 200 beds. The measure used here, the rated bed capacity, thus embodies the somewhat unrealistic assumption of perfect substitutability between beds set aside for various conditions and also assumes that 'rated beds' equals 'staffed beds'. It was considered preferable, however, to the other common measure in research in this area, namely patient days, the use of which involves the regression fallacy and which is at any rate more a measure of throughput than capacity.[9]

Finally, it was noted earlier that we would be using a behavioural average-cost equation. Conventional long-run average-cost curves of economics textbooks are 'logically predicated upon the existence of a production function which specifies, for any level of output, the efficient combination of relevant inputs' (Berki 1972, 85). There seems no reason to believe that hospitals in Canada operate as cost minimizers, combining inputs in the most efficient manner for any level of output. The absence of profit maximization as a behavioural motive and the sometimes conflicting objectives of the members of the hospital hierarchy

9 The regression fallacy may be illustrated simply by considering two hospitals, each reporting 10,000 patient days a year. Assume hospital A reports an occupancy rate, defined as total patient days divided by bed days (365 times BEDS), of 80 per cent. Hospital B on the other hand is underused all year and has an average occupancy rate of only 25 per cent. The use of hospital days as a scale measure describes these two hospitals as having equal capacity (or being of equal 'size'). Yet it is quite likely that hospital B will report a much higher average cost per case than hospital A, owing to the large fixed cost proportion of this figure. While a significant share of the variation in case costs might be the result of differences in rated bed capacity that year, the use of patient days will almost certainly lead to erroneous conclusions regarding scale effects. See also Feldstein (1967, 79-80).

(administrators, boards of trustees, and medical staff) make it unlikely that a hospital is operating at a point on an economically efficient production frontier.[10] The global-budgeting hospital reimbursement provisions that were in effect over the period of this analysis (1969-74), with their attendant 'window-dressing' incentive structures, did little to encourage cost minimization.[11] In short, the data base precludes the identification of economically efficient production functions, and we must be content with estimating cost equations whose 'parameters contain a mixture of behavioural and technical effects' (Evans and Walker 1972, 398). The equations are 'behavioural' in the sense that they describe the actual behaviour of the hospitals during the relevant period of time and claim nothing about attainable efficiency.

Having examined the common methodological issues involved in the estimation of hospital cost equations, described corrective approaches for some, and noted those that remain problematic, we specify the hospital cost model in the next sections. Those sections, which draw substantially on the earlier work of Evans and Walker (1972) and Barer (1977), detail the equations of the model, the construction of the variables, and the data sources for operationalizing those variables. In the final section of this chapter we look at the trends and interactions in some of those variables for Ontario hospitals in the period 1969-74.

A MODEL OF HOSPITAL COSTS

This study focuses on the inpatient care component of hospital activity. The model articulated here is based on an assumption that the total cost of treating

10 There is an abundant and growing literature on hospital behaviour. Reviews of that literature can be found in Migué and Belanger (1974), Pauly (1974), Evans (1970), Jacobs (1974), and Davis (1972). More recent explanations of the interaction of the various decision-making bodies within the hospital may be found in Harris (1977) and Sloan (1980).

11 In fact they were more likely to have encouraged prospective budget exhaustion. While the penalties for overruns were severe, and therefore encouraged hospitals to stay within their budgets, the rewards for underruns seem to have been devised by someone with a perverse sense of humour. In 1969 any underruns were to be returned to the Ontario Hospital Services Commission and the next year's budget bases reduced accordingly! Starting in 1970, hospitals were required to declare any savings to be either continuous or one-time. In the latter case the lucky hospital was entitled to retain 10 per cent of the underrun, and that year's savings had no effect on next year's budget. Savings declared as continuous left the hospital with two choices: to keep 90 per cent of the surplus and face a budget base in the following year reduced by 100 per cent of the surplus; or to keep a percentage of the surplus, related to the size of the underrun (75 per cent of the first half per cent of the budget 'saved', 80 per cent of the second half per cent, etc.), with a smaller reduction in the budget base. Little surprise, then, at the popularity of the one-time awards.

and caring for an inpatient population in any hospital in a given period is composed of a fixed component (per bed) and a variable component (per case or day).[12] We also allow for a possible non-linear impact of capacity on unit costs by entering the bed variable in quadratic form.[13] The specification of the crude model, when separations are the adopted measure of output, is

$$\mathrm{TC} = p_1 B + p_2 B^2 + p_3 C, \tag{1}$$

where TC is total inpatient cost, B is rated bed capacity and C is cases (separations in year). When days are the output measure,

$$\mathrm{TC} = p_4 B + p_5 B^2 + p_6 D, \tag{2}$$

where D is total days stay of all patients in a year. The parameters p_1, p_2, p_4, and p_5 are assumed to be constant functions, but p_3 and p_6 are hypothesized to depend on a number of variables relating to hospital activities and patient mix. It is the variable costs, then, that are assumed to be affected by the two dimensions of output heterogeneity in the hospital sector. The variable cost per separation (p_3) may reasonably be expected to vary with hospital average length of stay (ALA). It is also postulated that case mix (CMPXC1), specialization of the hospital (SPCLC1), and the age-sex composition of the patient load will affect the variable per-separation costs. In short,

12 In the context of inpatient expense, it is assumed that all expenses associated with a staffed bed are 'fixed,' while the remaining expenses that are a function of the occupancy of that bed are variable. The premise is, of course, that the costs of the capacity (both staff and equipment) necessary to support a potentially filled bed are fixed in the short run, whereas the variable costs of treatment, diagnosis, food, and laundry, for example, are incurred only as beds are filled.

13 This specification allows subsequent testing for evidence of economies of scale, although in the context of behavioural cost functions it is not clear what such evidence would indicate. Only if one could assume that the shape (if not the parameters) of the behavioural curve closely mirrored that of the minimum average cost curve could one attempt to infer anything about economies or optimal cost. See Berki (1972) for a more detailed discussion of this issue and a review of some of the relevant literature. That literature is, anyway, consistent only in its inability to produce consistent evidence on economies of scale. One might argue that analytical consistency here requires inclusion also of a C^2 term in the specification of the model. But economies are much less likely to be significant within the variable component of operating costs. Once a laundry service or kitchen has been established, for example, the variable costs would seem logically to be in proportion to the patient load. That argument was in fact tested empirically for acute care hospitals in both Ontario and British Columbia, and in no case was a significant parameter derived on either a C^2 or C^3 term (C and C^2 terms in the average cost formulation).

$$p_3 = f(\text{ALS, CMPXC1, SPCLC1, age-sex variables ... }).$$

The variable cost of a specific case may also be a function both of wages for non-medical staff and the skill mix of that staff. The specification of p_3 thus includes a variable to standardize for each of these potential inter-hospital variants.

We adopt a left-side activity mix standardization approach. This means that the numerator and denominator of the dependent variable (average cost per unit of output) must both be predicated on the same output base, but eliminates the need for a lengthy list of independent non-inpatient (in this case) activity variables on the right side of the equation. However, the costs of similar cases in different hospitals may vary because the effects of non-inpatient activities in some hospitals influence all hospital functions to some extent. For example, elimination of educational expenses as they appear in hospital accounts does not prevent the educational function and the expertise and capital attached to it from influencing the care received by all inpatients. Not only might the presence of teaching facilities pervade all aspects of hospital life, but that presence is likely also to affect the case mix. In short, secondary, indirect education effects on unit costs are quite likely.[14]

To this end we include three variables in the specification of p_3, for education, outpatient, and non-departmental (i.e. capital cost – rent, depreciation, and so on) expenditures to standardize for any indirect influence of these activities that extends beyond the items specifically allocated to those functions in the accounting framework. The complete specification of p_3 takes the following form:

$$\begin{aligned} p_3 = a_0 + a_1\,\text{CMPXC1} + a_2\,\text{SPCLC1} + a_3\text{EDRAT} + a_4\text{DEPRAT} + a_5 F_1 + \ldots \\ + a_{12} F_8 + a_{13}\,\text{OUTXPR} + a_{14}\,\text{WAGE} + a_{15}\,\text{SERV} + a_{16}\,\text{ALS}. \quad (3) \end{aligned}$$

Brief variable descriptions appear in Table 5, and details of their development are contained in Appendix A.

A similar set of assumptions leads to an identical specification of the p_6 function. One may reasonably expect the same set of variables to affect variable costs per day, but with different weights. For example it does not seem unrealistic that the higher a hospital's ALS is, the higher its value of p_3, variable cost per case, will be. Variable cost per day (p_6), however, might be expected to fall with increasing length of stay because treatment costs may decline towards the end of

14 In fact, the existence of such effects was demonstrated in Horne (1970).

TABLE 5

Variable acronyms and brief descriptions

Dependent variables	
CASEX	inpatient cost per hospital separation
CASEXD	inpatient cost per hospital separation in 1969 dollars
DAYEX	inpatient cost per hospital day
DAYEXD	inpatient cost per hospital day in 1969 dollars
Independent variables	
EDRAT	educational activity expenditure as share of total hospital operating costs
DEPRAT	non-departmental (e.g., interest and depreciation) expenditure as share of total hospital operating costs
OUTXPR	expenditures of organized outpatient and emergency departments, and other ambulatory care costs, as share of total hospital operating costs
$F_1 \dots F_8$	factor scores from a factor analysis of the inpatient age-sex distribution of separations across hospitals. See Appendix A for relevant loadings on original age-sex categories.
CMPXC1	complexity of hospital separations mix
CMPADJ	CMPXC1 adjusted for aggregate provincial changes in case mix (by using base year case complexities)
SPCLC1	a measure of hospital specialization; an indication of the degree to which a hospital is limited in its capacity to handle a wide range of case types
SERV	an indicator of the relative cost of a hospital's personnel (service) mix.
WAGE	an indicator of a hospital's relative wage level
ALS	average length of stay
OCC	occupancy rate
B	rated bed capacity

Note: More detailed descriptions appear in Appendix A.

a hospital episode. On the other hand, hospitals with long stays may be handling cases requiring significant utilization of treatment resources for longer periods of time. That would mean a positive impact of ALS variation on the variance in p_6. If some of each effect is operating, ALS may be an insignificant factor in the p_6 function. CMPXC1 should be a significant variable in p_6 as in p_3. Thus, we have

$$p_6 = b_0 + b_1\,\text{CMPXC1} + b_2\,\text{SPCLC1} + b_3\,\text{EDRAT} + b_4\,\text{DEPRAT} + b_5 F_1 + \dots$$
$$+ b_{12} F_8 + b_{13}\,\text{OUTXPR} + b_{14}\,\text{WAGE} + b_{15}\,\text{SERV} + b_{16}\,\text{ALS}. \quad (4)$$

If equations (3) and (4) are substituted respectively into equations (1) and (2), and the latter two equations are transformed to their respective per unit specifi-

cations (average cost per separation for equation (1), average cost per day for equation (2)), the following average cost equations result:[15]

$$\text{CASEX} = \text{average inpatient cost per separation}$$
$$= \text{TC}/C,$$

where TC is total inpatient expenditure and C is the number of inpatient discharges and deaths,

$$= p_1 B/C + p_2 B^2/C + a_0 + a_1 \text{ CMPXC} + a_2 \text{ SPCLC1} + a_3 \text{ EDRAT} + a_4 \text{DEPRAT} + a_5 F_1 + \ldots + a_{12} F_8 + a_{13} \text{ OUTXPR} + a_{14} \text{ WAGE} + a_{15} \text{ SERV} + a_{16} \text{ ALS}; \quad (5)$$

$$\text{DAYEX} = \text{average inpatient cost per day}$$
$$= \text{TC}/D,$$

where D is total days stay of all hospital patients,

$$= p_4 B/D + p_5 B^2/D + b_0 + b_1 \text{ CMPXC1} + b_2 \text{ SPCLC1} + b_3 \text{ EDRAT} + b_4 \text{ DEPRAT} + b_5 F_1 + \ldots + b_{12} F_8 + b_{13} \text{ OUTXPR} + b_{14} \text{ WAGE} + b_{15} \text{ SERV} + b_{16} \text{ ALS}. \quad (6)$$

Equations (5) and (6) then represent the manner in which we believe hospital costs behave. Inter-hospital variation in inpatient unit costs is postulated to be a linear function of the independent variables specified in those equations, which are listed in Table 5 and described in Appendix A. The equations undergo slight alterations as a result of methodological and econometric diagnoses noted in the rest of this chapter and in the estimation of the model in Chapter 4.

15 The CASEX equation is similar to that of Evans and Walker (1972). In fact, the CMPXC1, SPCLC1, EDRAT, DEPRAT, OUTXPR, ALS, and age-sex factor scores are identical in name and construction to variables in their model. But whereas they included ALS, CFR (case flow rate, which is defined as cases per bed year and is the reciprocal of our B/C variable), BEDS, BEDS^2, and OCC (occupancy rate), our initial model formulation incorporates the scale variables in the quadratic form of B/C, does not include OCC, and adds two new variables: WAGE and SERV. Barer (1981) discusses some of the problems in the Evans-Walker model that led to this re-specification.

SOURCES OF DATA

The pertinent hospital data necessary for computing values for the variables in equations (5) and (6) are of three general classes: facilities and services, expenditures, and utilization. All Canadian public general hospitals were required to fill HS-1 and HS-2 forms annually with the Health Division of Statistics Canada. The HS-1 form records facilities and services, while the HS-2 contains information about expenditures and revenue. The data supplied on these forms are coded and stored on magnetic tape.

In Ontario, hospitals had to file a 106-D form with the Ministry of Health for each inpatient separation. Some of the information recorded on those forms, including age, sex, length of stay, and principal diagnosis for all patients released from each hospital is also coded and stored on tape.

The model estimation described in Chapter 4 is a time-series/cross-section study of 182 hospitals over the six years 1969-74. The Ministry of Health discharge records contained information about Ontario patients treated in up to 376 different facilities in any given year. Of those, all hospitals and units not designated as public general hospitals providing active treatment in Ontario were eliminated. Thus all private facilities, federal hospitals, general and special rehabilitation hospitals, public and private chronic care hospitals, nursing homes, hospitals and units treating nervous and mental ailments, and out-of-province hospitals were removed from the total set. This reduced the sample to 219 hospitals. Several more were either closed during the six-year study period or were not in operation at the beginning of the period. This process of attrition led to the following sample sizes for each year: 1969 – 212, 1970 – 211, 1971 – 209, 1972 – 212, 1973 – 209, 1974 – 210. These sets of hospitals were used in each year to construct the provincial case complexities (a process described in Appendix A). Different data and decision rules but a similar process were used to define the set of 182 hospitals for the cost analysis. From those hospitals that filed HS-1 and HS-2 returns in each year, any hospital eliminated in the process described above as well as any hospital that was not subject to budget review, that was classified as a Red Cross outpost, or that filed incomplete information in one or more years of the study period was removed from the sample. Finally, any hospital that shifted its major function, say from acute to chronic care, was eliminated.[16] This series of refinements left a uniform set of 182 hospitals for each of the six years.

16 For example the Niagara Peninsula Sanatorium reported thirty-four medical and surgical beds and twenty-five chronic beds in 1969. On that basis it would have been included in our sample. But during the 1969-74 period it became The Shaver Hospital for Chest Diseases, with

In the next section we look briefly at the values and trends of some of the variables listed in Table 5.

THE EXPERIENCE OF ONTARIO HOSPITALS, 1969-74

Table 6 illustrates the experience of the 182 hospitals during 1969-74. They represented 87.5 per cent of total gross operating costs for the 236 provincial hospitals listed in the Ontario Ministry of Health's *Hospital Statistics 1974*. A number of interesting trends are evident. Both ALS and occupancy rate fell fairly steadily over the five-year period, while operating costs rose 81 per cent and estimated inpatient expenditure rose 85 per cent. Although separations increased somewhat more (13.8 per cent) than bed supply (4 per cent), the fall in length of stay was enough to produce an overall drop in occupancy rate for this set of hospitals.

The slightly faster increase in inpatient expenses in relation to that of total operating costs is reflected in two interesting trends reported in Table 7. That relationship between inpatient and total costs means that some non-inpatient activities must have been declining in hospital budget importance. One of those activities was education, which fell from 6.5 per cent of operating costs in 1969 to 3.6 per cent in 1974. This drop reflected not an absolute decline in nominal dollar expenditure for educational activities in these hospitals, but an almost constant annual level of education expenditure at a time when total budgets were expanding rapidly. This trend undoubtedly reflects the shift of nursing diploma programs from hospitals to community colleges in 1973. The Ministry of Health's report of operating costs across departments for all Ontario hospitals shows per diem medical education costs of $1.35 in 1969, increasing to $2.02 in 1972 and to $2.83 in 1974. In contrast, the corresponding figures for nursing education figures are $1.69, $1.95, and $0.20 respectively (Ontario n.d. 1971, 1974, 1976c).

The increase in the share of operating costs being absorbed by outpatient activities may reflect a shift in the policy of physicians. Outpatient departments and emergency departments, traditionally viewed as complements to private practitioners' offices for primary care, are perhaps being used more and more as substitutes. The tale of phoning one's physician and being sent to an emergency ward is told often, and any significant increase in that practice would be reflected

thirty-five rated 'active' beds and fifty-five chronic beds in 1974. This suggests that for part of the period the hospital functioned primarily as a chronic care facility; accordingly it was not included in the cost analysis.

TABLE 6

Selected descriptive statistics for 182 Ontario hospitals

	1969	1970	1971	1972	1973	1974
Rated bed capacity (B)	40826	41348	42015	41916	41460	42486
Total separations (SEPNS)	1,245,361	1,325,782	1,362,530	1,389,230	1,395,954	1,417,821
Total days stay (DAYS)	13,190,970	13,553,784	13,560,591	13,332,560	12,808,267	12,966,222
Separated days stay (SDS)	13,166,584	13,526,549	13,574,628	13,338,041	12,826,054	12,910,333
Average length of stay (ALS)	10.57	10.20	9.96	9.60	9.19	9.11
Provincial occupancy rate (OCC)	0.885	0.898	0.884	0.871	0.846	0.836
Total estimated inpatient expenditure (current $000)	550,968.3	622,037.5	695,037.7	765,133.6	826,188.3	1,021,040.6

NOTE: A list of included hospitals is available from the author. ALS and OCC refer to provincial average length of stay and occupancy rate, rather than the average of the 182 hospitals' ALS and OCC values. Thus, $\text{ALS}_p = \text{SDS}_p/\text{SEPNS}_p$ and $\text{OCC}_p = \text{DAYS}_p/B_p \cdot 365$, where p denotes provincial (182 hospital) totals.

TABLE 7

Cost and activity trends in 182 Ontario hospitals

	1969	1970	1971	1972	1973	1974
Total operating expenditure per inpatient day	52.61	58.33	65.35	73.08	81.34	96.88
CASEX	442.42	469.19	510.11	550.76	591.85	720.15
CASEXD ($1969)	442.42	433.23	437.11	439.20	433.27	442.08
DAYEX	41.77	45.89	51.25	57.39	64.50	78.75
DAYEXD ($1969)	41.77	42.38	43.92	45.76	47.22	48.34
OUTXPR	0.064	0.068	0.072	0.075	0.079	0.082
EDRAT	0.065	0.070	0.068	0.065	0.054	0.036

NOTE: These variables are based on the aggregated values of the numerator and denominator for the 182 hospitals rather than the average of the 182 hospital values for each variable. See Appendix C for a description of the deflator used in converting CASEX and DAYEX to constant dollar values (CASEXD and DAYEXD).

in this trend. While the cost savings expected from the substitution of ambulatory for inpatient care have long been expounded, this particular trend does not seem to be the result of any significant shift away from inpatient care. Total inpatient separations for adults and children in Ontario increased 18 per cent from 1.15 million in 1969 to 1.36 million in 1974, while Ontario's population grew by only 9.6 per cent.[17]

The remaining data in Table 7 concern costs per separation and per patient day. Inpatient cost per case increased 62.8 per cent, while the comparable (inpatient) per diem rose 88.5 per cent, the discrepancy again reflecting the fall in ALS. The result of applying the deflator (the construction of which is described in Appendix C) to the DAYEX and CASEX figures is given by the constant (1969) dollar series. These series also reflect the declining average length of stay, because CASEXD remained relatively stable over the six years while inpatient cost per day increased in real terms by 16 per cent.

To summarize, operating costs grew rapidly during this five-year period, but the impetus for the increase did not come from the utilization side. Total days stay actually fell slightly, as a result of a consistent decline in lengths of stay. In fact, as Appendix C shows, a major share of the cost increase was the result of a dramatic rise in the level of wages.

17 The figures on separations come from the Ontario Ministry of Health's annual *Hospital Statistics*, while the data on the population of Ontario are from Ontario (1978).

Table 8 shows average (over the six years) correlations between pairs of independent variables used to estimate the parameters of the model. While seven pairwise correlations took on values greater than 0.5 (absolute value), only two were large enough to introduce critical collinearity problems. The correlation of B/D and OCC (-0.954) is to be expected, since these two variables are linked by definition. In any event OCC was not one of the independent variables in our DAYEX equation. The correlation of B/C and ALS (0.923) is more serious. It seems to indicate very low variance across hospitals in occupancy rates, since if all hospitals had identical occupancy rates, B/C would be approximately proportional to OCC/ALS (the degree of approximation being a function of the relationship between total days (DAYS) and total days for separations (SDS)). This is confirmed by the fact that, for example, in 1972 the average of the hospitals' occupancy rates was 0.852, with a standard deviation of 0.109. Because of the magnitude of this correlation, a decision was made to substitute OCC for ALS in the CASEX equation. Since OCC, ALS, and B/C are closely related by definition, this made possible the elimination of the collinearity while allowing retention in the model of two of the three variables.

Other correlations of an absolute magnitude greater than 0.5 seemed not to warrant specific alteration to the model but do concur with a priori expectations. The correlations of B^2/C and B^2/D with EDRAT are a result of larger hospitals being the dominant institutions in medical and nursing education. Similarly, the same large teaching hospitals would be expected to treat relatively complex case mixes, as suggested by the correlations of CMPXC1 with B^2C, B^2D, and EDRAT.

CONCLUSION

In this chapter a model of hospital cost behaviour has been specified incorporating both activity mix and case mix dimensions that may be expected to generate inter-hospital variance in unit costs. The construction and data sources for each of the model's variables have been outlined, with a more detailed treatment of their construction appearing in Appendix A. Finally, we have taken a brief look at provincial trends in a selected number of those variables.

Chapter 4 deals with the various stages of the model estimation. While all the independent variables described in this chapter and in Appendix A were included in alternative specifications during the early stages of model estimation, some paring took place fairly quickly. In particular, CMPXC1 was found to be superior to two alternative case-mix specifications (CMPXC2, CMPXCW), SPCLC1 similarly surpassed the explanatory power of SPCLC2 and SPCLC3, and ALS was dropped in favour of OCC in the CASEX equation. For the sake of brevity, these early estimations are not reproduced in Chapter 4.

TABLE 8

Average correlations between selected independent variables

	B/C	B^2/C	B/D	B^2/D	EDRAT	DEPRAT	OUTXPR	WAGE	SERV	ALS	OCC	CMPXC1	SPCLC1
B/C	1.00	0.390	—	—	0.059	0.058	–0.179	–0.112	–0.041	0.926	–0.290	0.049	0.313
B^2/C		1.00	—	—	0.576	–0.119	–0.133	0.269	–0.122	0.428	0.063	0.548	–0.046
B/D			1.00	–0.125	–0.196	0.344	0.021	–0.091	0.079	–0.118	–0.954	–0.194	0.128
B^2/D				1.00	0.682	–0.131	–0.119	0.344	–0.148	0.203	0.104	0.612	–0.147
EDRAT					1.00	–0.161	–0.134	0.205	–0.159	0.136	0.184	0.566	–0.098
DEPRAT						1.00	–0.072	–0.096	0.126	–0.078	–0.311	–0.069	0.138
OUTXPR							1.00	–0.008	0.225	0.201	–0.033	0.028	–0.003
WAGE								1.00	–0.006	–0.078	0.116	0.410	0.033
SERV									1.00	–0.080	–0.096	0.046	0.173
ALS										1.00	0.072	0.121	0.283
OCC											1.00	0.187	–0.101
CMPXC1												1.00	0.370
SPCLC1													1.00

4

Model estimation

Chapter 3 described the behavioural hospital cost model and reported independent variable correlations and dependent variable trends. This chapter and Appendix E continue from that correlation analysis to describe the two stages in the estimation of the model parameters using our six years of cross-section data.

The first stage, single-year, ordinary least squares estimation of the two equations facilitated the paring of always insignificant variables from the equation specifications. This was followed by maximum-likelihood estimation of the parameters for each equation. The preliminary OLS analysis was necessitated by the set-up and computer-time costs of using an adaptation of the Chow and Fair (1971) full-information maximum-likelihood estimation package (Wales 1975) on a model of this size. In turn the MLE stage was necessary in order to take account of the fact that the OLS parameter estimates resulting from a straight pooling of the six years into a 1092-observation cross section are inefficient (in the sense that there exist lower-variance unbiased estimators) as a result of the autocorrelation among the OLS residuals. Details are in Appendix E.

The sheer volume of equations that were estimated at various stages of this analysis prevents our reporting the results from all of them. Much of the early econometrics was devoted to a comparison of the relative explanatory powers of alternative combinations of complexity and specialization variables. As noted in Chapter 3, CMPXC1 was in all cases the variable of choice when compared to CMPXC2 and CMPXCW, and similarly SPCLC1 won out over SPCLC2 and SPCLC3. Therefore, only those equations containing one or both of CMPXC1 and SPCLC1 are carried forward through this and the following chapter.

Two other alterations should be mentioned here. The simple correlations reported in Table 8 revealed almost perfect collinearity of ALS and *B*/*C*, and as noted in the discussion of that table OCC was accordingly substituted for ALS in the CASEX equation. Although there was no similar problem of correlation in

the DAYEX equation, the lack of explanatory power (significance) of ALS in that equation led to its early elimination there as well. The insignificance of the ALS variable in the DAYEX equation was somewhat surprising, since a plausible case could be made for it to have a significant negative influence. If the hospitals that have shorter lengths of stay are providing more intensive daily care so as to facilitate earlier discharge, their inpatient per diems would be expected to be relatively high. Although such hospitals may also have short lengths of stay because of a relatively straightforward case mix, that is not indicated by the correlation between CMPXC1 and ALS (0.12). One possible explanation for the variable's insignificance may be found in the B/D variable – $B/D = (B/C) \cdot (C/D)$, and C/D is approximately the reciprocal of ALS. While B/D and ALS were not highly correlated (-0.12), the B/D variable was more strongly significant in equations without ALS. As a result, then, ALS was dropped from both equations.[1]

In light of this summary of the early estimation stage, the results reported in Appendix E start from a CASEX equation identical to that specified as equation (5) in Chapter 3, with the exception of the OCC for ALS substitution. Equation (6) of that chapter is adopted without the ALS variable. B/C was expected to have a positive influence on CASEX, since an increase in B/C (all else, including OCC, unchanged) would be a result of an increase in ALS, which in turn would be expected to raise inpatient cost per case.[2] The quadratic term, B^2/C, could be expected also to reflect some of this interaction with ALS. Furthermore, its positive correlation with EDRAT, WAGE, and CMPXC1 (Table 8) are additional reasons for believing that hospital size would exert a strong non-linear effect on CASEX. What is uncertain at this stage, of course, is how many of the 'additional reasons' will be captured by those independent variables.

A similar line of reasoning suggests a positive influence of OCC on CASEX. Since $\text{OCC} \simeq (\text{CFR})(\text{ALS})/3.65$, holding $B/C = 1/\text{CFR}$ constant implies that any increase in OCC must come from an increase in ALS. We have already argued for a significant positive influence of ALS on CASEX; hence our expectation for the OCC parameter. This is not what one would expect if the source of changes in

1 No substitution of OCC for ALS was possible in the DAYEX equation for two reasons. The first and most important of these was the collinearity of OCC and B/D. But in addition the insignificance of ALS suggests that OCC would also have been insignificant in explaining the variation in DAYEX. Instead of using B/D as the independent variable in the DAYEX equation, a combination of B/C and C/D might have been tried, thus allowing the independent estimation of the effects of case flow and average length of stay on DAYEX. But this method is quickly ruled out when one recalls the reason for substituting OCC for ALS in the CASEXD equation – the extremely high correlation of B/C and ALS.

2 This follows from the approximate relationship between B/C, ALS, and OCC: $C/B \simeq 3.65$ OCC/ ALS.

hospital occupancy rates were ignored. It may be argued that higher-occupancy hospitals will be able to spread their fixed costs over more cases and thus lower their cost per case. That of course neglects the fact that higher occupancy rates can also be caused, other things being equal, from increased lengths of stay. A higher occupancy rate resulting from an increased rate of admissions (i.e. no change in ALS) would be reflected in a higher case flow rate, a lower value of B/C, and an expected fall in CASEX. But that effect cannot appear in this particular model because the parameter estimates represent the independent effects of B/C and of OCC on CASEX, with the other being held constant. Both influences, then, work through the role of ALS on CASEX.

Turning to the DAYEX equation, if ALS has no significant effect on DAYEX, then any influence of B/D will derive from its B/C component. We would then expect positive and significant parameters on both B/D and B^2/D for reasons similar to those offered above in the discussion of the B/C and B^2/C variables.

The remaining independent variables appear in both equations. It was noted in Chapter 3 that all non-inpatient expenditures were extracted from TOTEX (total expenditure) to derive CASEX and DAYEX as inpatient-specific cost measures. We would then expect no significant impact of EDRAT, DEPRAT, or OUTXPR on either CASEX or DAYEX unless those variables had secondary, indirect influences on inpatient care. Of the three variables, the one representing the teaching activities of a hospital (EDRAT) is the most likely to have indirect effects.

We would expect the WAGE parameter to be positive, because relatively high wages will be reflected directly in relatively high costs, per case and per day, after the effects of all other independent variables have been accounted for. Similarly, a hospital with a relatively costly personnel mix (SERV) would be expected, other things being equal, to have high CASEX and DAYEX values.

Hospitals with relatively complex case mixes are likely also to be the hospitals with relatively high costs, both per case and per day. However, since length of stay is in principle far more important in CASEX variance, we might logically expect a more significant role for CMPXC1 in the DAYEX than in the CASEX equation. The likely effect of SPCLC1 is somewhat more difficult to determine. Recall that the SPCLC1 variable was intended to represent the degree to which hospitals diversified in their treatment of diagnoses. There are at least two reasons for a hospital to have a high SPCLC1 value. First, a small hospital will not have the physical or technical capacity to treat many diseases. Second, a hospital will have a high SPCLC1 value if it specializes in treating one or a few types of cases. During 1969-74, the two hospitals with by far the highest SPCLC1 values in Ontario were the Princess Margaret Hospital, a cancer institute, and the Orthopaedic and Arthritic Hospital, both in Toronto. Since a significant share of the total variance in this variable is that of those two hospitals, for this particular

data set we might expect that the influence of SPCLC1 on CASEX and DAYEX will to a great extent be dictated by the relative unit cost positions of those two hospitals and by the degree to which those positions are explained by the other variables. It is difficult on that basis to say anything about what sign is expected on the SPCLC1 parameters. At a more general level, since one would expect number of beds and SPCLC1 to be negatively correlated (since the majority of 'high specialization' hospitals are likely to be small institutions) one might expect a negative coefficient at least in the CASEX equation. It is difficult to determine however whether that impact will be captured by CMPXC1 (this type of hospital will probably also have low CMPXC1 values) and OCC (representing ALS), or by SPCLC1. In short, even guessing at the sign or significance of this parameter seems hazardous and not very productive.

Appendix A contains a summary of the loadings of the eight age-sex factors on the forty-four original age-sex groupings. Factor 1 seemed to represent the proportion of separations within the 75+ age group. We would, then, expect a positive coefficient on F_1 in the CASEX equation, since this age group is generally hospitalized for chronic conditions requiring long stays. However, chronic cases will not usually require highly resource-intensive acute care on a daily basis, so that we would expect a negative coefficient on F_1 in the DAYEX equation. The second factor, F_2, loaded on both sexes 14 years and under. We would expect the pattern for this factor to be exactly the opposite of that for F_1: a positive impact on DAYEX and a negative impact on CASEX. Children are usually admitted to hospital for acute conditions requiring immediate and often intensive treatment, but they also recuperate quickly and are generally not admitted for conditions requiring long stays in hospital. Even when they do contract a chronic illness needing long treatment, they are usually treated in a series of hospital visits rather than through prolonged hospitalization.

The only other factor that loaded consistently on the same set of age-sex categories for all six years was F_5, which was related to women aged 45-64. This covers of course the menopause period and is characterized by a high incidence of non-specific symptoms that often require lengthy and costly diagnosis. If anything, then, we might expect positive parameter estimates in the CASEX equations, but there is little on which to base a prediction for the DAYEX impact. Factor 3 represented men aged 50–74 in 1969, 1970, 1972, and 1973, and it seems safe to suppose that a disproportionate number of patients in this age group would exert upward pressure on a hospital's CASEX value. Since male life expectancy is less than the upper limit of this age group, it too will include large numbers of chronic cases and diseases generally requiring long periods of recuperation. In the other two years, 1971 and 1974, F_3 loaded most strongly on men 20–49 years

old. If anything, we might expect a weak negative impact on CASEX in those years. Since F_3 (i.e. loaded strongly on men 20–49 and 50–74 in the years when F_3 did not), similar results would be expected there. F_6, F_7, and F_8 did not exhibit any significant loadings.

ECONOMETRIC ANALYSIS

The bulk of discussion of econometric methodology and early results may be found in Appendix E. Briefly, the first step was year-by-year ordinary least squares regressions (Tables E.1 and E.2). The results of that stage indicated that, of the three non-inpatient care variables, only EDRAT (education expense) seemed to generate a significant indirect impact. It appears, then, that the sphere of influence of teaching hospitals extends beyond the narrow confines of the educational activities themselves. As expected, non-departmental items and outpatient activities did not significantly influence inpatient cost per case or day. Therefore, these two variables (DEPRAT and OUTXPR) were dropped from the remaining stages of the analysis.

Relative costliness of personnel mix was found also to be an insignificant factor. In the CASEX equation, it might be argued that relatively high wage mixes of personnel make earlier discharge possible for any given case, so that CASEX is not unduly affected. Our data suggest another explanation, however. There was very little variance in SERV: for example, in 1969 the mean value was 1.003 and the standard deviation 0.031. The implied variance was far less for this variable than for any of the other variables in the model in comparison to their respective means. This might then explain its insignificance in the DAYEX equation as well. That variable was also eliminated from the subsequent analysis.

The two equations were then re-estimated for the six years, minus these three independent variables (Tables E.3 and E.4). Not surprisingly, neither the explained variance nor the remaining independent variable t-values changed to any great extent.

The third step in the process entailed pooling the six years of data. For statistical reasons, described in Appendix E, ordinary least squares estimation could not be used. Instead maximum-likelihood parameter estimates were derived from a six-equation model (one equation per year). At this stage, CASEXD, DAYEXD, and CMPADJ were substituted for CASEX, DAYEX and CMPXC1 respectively, to take account of input price inflation (CASEXD, DAYEXD) and provincial case complexity trends over time (CMPADJ).

The results of this maximum likelihood estimation appear in Tables 9 and 10.

TABLE 9

Maximum likelihood estimation 1, dependent variable CASEXD

	1969	1970	1971	1972	1973	1974
B/C	4387.3	4053.2	4159.1	4460.0	4041.0	5150.4
	(10.9)	(10.5)	(11.4)	(11.4)	(8.92)	(11.7)
B^2/C	4.065	3.612	3.830	3.832	3.650	3.829
	(10.6)	(8.70)	(9.32)	(7.84)	(6.40)	(6.01)
OCC	100.8	91.24	104.5	126.8	132.4	159.2
	(5.05)	(4.43)	(6.07)	(6.36)	(5.73)	(6.04)
EDRAT	177.0	162.6	147.5	28.23	140.9	508.8
	(1.97)	(1.90)	(1.83)	(0.38)	(1.43)	(3.57)
WAGE	197.5	144.6	152.2	166.9	135.5	243.5
	(5.03)	(3.59)	(4.00)	(4.54)	(3.30)	(4.76)
CMPADJ	92.37	59.60	74.17	127.3	33.74	-32.80
	(2.15)	(1.78)	(2.16)	(3.74)	(0.99)	(0.91)
SPCLC1	17.20	18.96	19.10	21.11	19.68	26.83
	(7.44)	(6.70)	(7.15)	(7.45)	(5.70)	(6.42)
F_1	14.06	17.04	19.44	16.37	15.56	20.29
	(4.18)	(5.24)	(5.73)	(4.92)	(4.13)	(4.62)
F_2	-8.441	-10.41	-8.336	-8.349	-7.254	-9.018
	(2.73)	(3.27)	(2.87)	(2.76)	(2.04)	(2.22)
F_3	15.64	9.536	-1.012	16.29	15.29	-9.415
	(4.58)	(2.60)	(0.45)	(5.34)	(4.17)	(3.17)
F_4	1.359	-0.339	13.94	-6.522	-2.359	12.74
	(0.56)	(0.13)	(4.58)	(3.02)	(0.93)	(3.23)
F_5	11.29	12.58	11.68	9.677	10.45	0.196
	(3.78)	(4.38)	(4.94)	(4.24)	(3.96)	(0.06)
F_6	-3.845	0.072	0.351	-3.229	7.297	-3.223
	(1.75)	(0.04)	(0.22)	(1.82)	(3.25)	(1.14)
F_7	3.364	-5.233	-7.764	-5.553	-2.446	1.056
	(1.78)	(2.33)	(3.79)	(2.77)	(1.33)	(0.54)
F_8	0.785	2.887	-1.199	0.560	0.706	1.494
	(0.48)	(1.72)	(0.82)	(0.43)	(0.40)	(0.62)
Constant	-170.5	-69.29	-102.1	-184.4	-59.59	-162.7
$\bar{R}^2$	0.858	0.800	0.826	0.818	0.756	0.792
SEE	54.12	62.09	58.88	60.80	69.53	75.10

NOTE: t-statistics in parentheses

Interpretation of MLE Results

Tables 9 and 10 show that the behavioural factors underlying variance in hospital inpatient costs shifted in weight over this six-year period. In the cost-per-case equation, both magnitude and significance of the scale/throughput variables (B/C, B^2/C) and WAGE remained relatively stable. The impact of OCC (and thus of ALS) grew over the last three years, apparently at the 'expense' of case-mix complexity. This suggests that length of stay variance began to over-

TABLE 10

Maximum likelihood estimation 1, dependent variable DAYEXD

	1969	1970	1971	1972	1973	1974
B/D	2324.3	2815.3	2398.9	1414.3	1744.5	1020.5
	(7.65)	(11.5)	(10.8)	(5.31)	(7.44)	(3.00)
B^2/D	1.991	2.040	2.293	2.343	2.620	2.543
	(4.56)	(4.55)	(5.83)	(5.12)	(5.55)	(5.15)
EDRAT	8.216	12.02	10.34	0.353	5.590	44.60
	(1.05)	(1.68)	(1.66)	(0.05)	(0.65)	(3.48)
WAGE	27.76	26.25	27.49	28.25	27.18	19.87
	(8.08)	(7.91)	(9.04)	(8.03)	(7.89)	(4.48)
CMPADJ	16.32	13.88	14.23	20.64	16.33	12.64
	(4.39)	(4.92)	(5.07)	(6.70)	(5.84)	(4.31)
SPCLC1	0.770	0.868	0.786	1.045	0.772	1.061
	(4.18)	(4.10)	(3.93)	(4.64)	(3.07)	(3.65)
F_1	−0.447	−0.398	−0.233	−0.234	−0.439	−0.558
	(1.94)	(1.70)	(1.02)	(0.92)	(1.65)	(1.76)
F_2	0.173	0.232	0.215	0.227	0.611	0.449
	(0.70)	(0.95)	(0.93)	(0.87)	(2.17)	(1.44)
F_3	0.000	−0.254	0.004	0.465	0.345	0.043
	(0.00)	(0.95)	(0.03)	(1.75)	(1.22)	(0.18)
F_4	0.131	−0.127	0.198	−0.198	0.126	−0.072
	(0.69)	(0.68)	(0.84)	(1.05)	(0.65)	(0.23)
F_5	0.171	0.036	0.082	0.170	0.279	0.265
	(0.74)	(0.17)	(0.44)	(0.81)	(1.30)	(0.96)
F_6	−0.297	−0.313	−0.259	0.135	0.051	0.090
	(1.62)	(2.17)	(1.99)	(0.82)	(0.27)	(0.39)
F_7	0.044	−0.272	−0.035	0.022	−0.083	0.001
	(0.28)	(1.66)	(0.23)	(0.12)	(0.54)	(0.00)
F_8	−0.114	−0.152	−0.029	0.027	−0.032	0.071
	(0.87)	(1.27)	(0.28)	(0.22)	(0.23)	(0.37)
Constant	−13.67	−11.42	−10.65	−12.65	−7.608	5.538
$\bar{R}^2$	0.643	0.634	0.634	0.649	0.605	0.593
SEE	3.77	4.03	4.05	4.39	4.76	4.98

NOTE: t-statistics in parentheses

power that of case mix as the period of analysis progressed. In addition, education activities became more important in 1974, a fact discussed below. Hospital specialization also grew in importance but much more gradually. Of the factor scores, F_1 through F_4 were relatively stable when one recalls the switching of loadings for F_3 and F_4. With the puzzling exception of 1974, F_5 maintained a stable, significant, and positive impact on CASEXD. F_6, which exhibited no discernible pattern of loadings on the original age-sex categories, not surprisingly bounced around in an apparently haphazard fashion. The only

pattern evident for F_7 is the significant negative parameters in 1970-2, years during which F_7 loaded most strongly on the two categories representing males and females aged 15-19. F_8, like F_6, did not exhibit any specific relationship with the original age-sex proportions, so that its insignificance in all six years ($p > 0.05$) is not surprising.

Turning to the DAYEXD results, we find that B/D declined in importance as the period wore on, although it remained a significant factor throughout. The quadratic term (B^2/D), CMPADJ, SPCLC1, and the factor scores were relatively stable. One exception was F_6, which was significant in 1970 and 1971, during which its largest loadings (although not extraordinarily strong) were on the female 30-44 years' group. WAGE appears to have declined slightly in importance in 1974, while EDRAT became dramatically more important in the same year. Are these results and patterns what we might have expected, and what do they seem to tell us about the behavioural impact of each variable on the cost measures?

The sign and significance of the parameter estimate for B/C was as expected. An increase in case flow rate, other things being equal, would be expected to have a strong and negative effect on CASEX, since it would entail a decline in ALS (for OCC constant). If we take the average of the six years' estimates, 4375, and consider a fictitious representative hospital of 500 beds with a case load of 16,000 discharges, a 5 per cent increase in case load (to 16,800 cases per year) would yield a drop in inpatient cost per case of approximately \$6.50 (in 1969 dollars). That would be a direct result of a decline in ALS from approximately 9.1 days to 8.7 days (assuming a constant occupancy rate of 80 per cent).

While a \$6.50 decline in cost per case, scarcely more than one per cent of the provincial average of \$440 (also in \$1969), may seem surprisingly low, the impact of such an increase in case load will not be restricted to the effect working through B/C. The B^2/C variable, too, will be affected. The mean coefficient on this variable is 3.803. Therefore the 5 per cent increase in separations translates, through B^2/C, into a \$2.83 drop in CASEXD, so that the total impact is a decline of \$9.33, a drop in the provincial average of slightly more than 2 per cent.

The values of B/C and B^2/C will also shift if bed supply is changed. A 5 per cent decline in rated bed capacity (to 475 beds) would require a fall in ALS from 9.13 to 8.67 days, a 5 per cent reduction in separations, or some combination of shifts in ALS and C, if OCC is again to remain constant. Of course offsetting 5 per cent drops in C and B will have no impact on CASEX through B/C but will still work through B^2/C. In this example, CASEXD would be reduced by \$2.97 in the absence of any shift in OCC or ALS. The implication seems to be that larger is not necessarily cheaper. In fact the positive coefficients on both B/C and B^2/C are indicative of scale dis-economies over the entire size range of hospitals in this

sample. A decline in ALS (to 8.67) to offset the 5 per cent reduction in beds would of course alter the values of both B/C and B^2/C (because OCC is assumed unchanged) and would lead to an aggregate drop of \$12.63 in CASEXD. Finally, if we choose a combination of shifts in C and ALS that maintain the constant occupancy rate, such as 500 fewer separations (total: 15,500) and a decline in ALS to 8.95 days, the aggregate impact on CASEXD will be seen as a reduction of \$6.71, and other combinations of total separations between 15,200 and 16,000, and ALS values between 8.67 and 9.13 would yield drops in CASEXD of between \$2.97 and \$12.62. It is also possible, of course, to have a larger than 5 per cent decline in separations, say to 14,400, which would require an increase in ALS (to 9.63 days) to maintain the constant OCC rate. This particular combination would induce a \$7.77 increase in CASEXD, not surprising in light of the fact that fixed costs remaining after the 5 per cent reduction in beds must be spread over 10 per cent fewer cases.

There is another variant to these interactive effects on CASEX yet to be considered. Let us assume now that ALS remains constant, so that changes in B/C also imply OCC changes, and vice versa. Returning to the first example, in which separations increased by 5 per cent to 16,800, if ALS is to be unchanged (recall that in that example it fell to 8.7 days), OCC must increase by 5 per cent to 84 per cent. The mean coefficient on OCC over the six years is 119.2, so that the effect on CASEX working only through the OCC variable would be an increase of \$4.77 (119.2 times 0.04). The decline in CASEX resulting from reduced values of B/C and B^2/C would amount to \$9.33 as before, so that the aggregate impact would be a CASEXD value lower by \$4.56. In other words, if there is an increase in separations and a fall in ALS, the decline in CASEX will be greater than if ALS remains unchanged and OCC rises. If, instead of C shifting, rated bed capacity again drops by 5 per cent to 475 beds, occupancy rate would increase to 84.2 per cent and the aggregate impact would be a drop of \$7.62 (\$12.63 − \$5.01) in CASEXD. In general, then, when a decline in B/C results from (or leads to) a fall in ALS, the negative impact on CASEX is greater than when that decline induces an increase in occupancy rate.

The EDRAT variable is extremely interesting in that it is close to significance (at a 5 per cent confidence level) for the first three years of the CASEXD analysis, becomes an insignificant factor in 1972, begins to re-emerge as an activity of some importance in 1973, and finally plays a large and significant role in explaining CASEXD variance in 1974. It is probably not coincidental that 1974 was the year in which the province-wide decline in in-hospital education was most marked (see Table 7). That was a result of the transfer of nursing education from hospitals to community colleges. This trend in the education parameter probably reflects the fact that before the nursing education shift many more

hospitals took part in nursing education than in medical education,[3] and thus more hospitals in general took part in some aspect of education. If there were any significant fixed costs associated with being a teaching hospital (medical or nursing) and if all hospitals were involved in education, we might expect a relatively minor role for the EDRAT variable. Once education is restricted to only about 50 of the 182 hospitals in our sample (as in 1974), and since in the hospitals where only nursing education is undertaken that activity is a minor one (almost always less than 2 per cent of total operating costs), we would expect variance in EDRAT to have a far greater influence on CASEXD. The reduced in-hospital education in 1973-4 is associated not only with the dramatic increase in significance of the EDRAT parameter but also with the disappearance of CMPADJ as a significant factor. The existence of in-hospital medical education is likely to influence case mix, and the EDRAT trends undoubtedly reflect the increasing importance of education as it became predominantly medical education. But they also suggest that EDRAT was capturing some share of the CMPADJ effect in 1973-4. This agrees with the correlation of these variables over the six years. While it was an almost constant 0.53 from 1969 through 1972, in 1973 it jumped to 0.61 and in 1974 increased further to 0.63. This impression is also supported by a comparison of identical 1974 ordinary least squares equations, one including EDRAT, the other not. In the latter case, the CMPXC1 coefficient was positive and strongly significant, whereas in Table E.3 it was marginally so. In general, then, the significance of the EDRAT variable coefficient suggests that, indeed, the influence of teaching activities extends far beyond the cost of the activities themselves.

To give an idea of the magnitudes involved, an increase in EDRAT, say from 0.05 to 0.06 would have led to CASEXD values higher by anywhere from \$0.28 (1972) to \$5.09 (1974). The latter figure would of course be more representative of the current situation in Ontario (all these estimates are in constant 1969 dollars).

From 1969 to 1972 the coefficient on CMPADJ was as expected – positive and (usually) significant. In 1972, when the EDRAT coefficient was not significantly different from zero at any reasonable confidence level, CMPADJ was most significant, again suggesting the complementary nature of the two variables. The

3 According to the Ontario Ministry of Health's publication, *Hospital Statistics*, in 1972, 81 of 196 general hospitals reported non-zero per diem operating cost allocations to nursing education, compared to only 35 hospitals for medical education. In 1974, however, 32 hospitals reported non-zero allocations to medical education, and the same number (although often not the same hospitals) had positive nursing education per diems.

majority of hospital complexity measures fall in the range 0.75 to 1.25.[4] Thus a hospital with a CMPADJ value of 1.0 may have been expected to have per case costs $12-$25 higher than a hospital that, other things being equal, had a CMPADJ value of 0.80 over these four years. While we have already noted the likely interaction of EDRAT and CMPADJ as a possible reason for the insignificant parameter estimates on the latter variable in 1973 and 1974, these results are nevertheless unexpected. While a plausible case was offered for CMPADJ to be more significant in the DAYEX specification than in the CASEX equation, the CASEX results found here for 1973 and 1974 were particularly surprising in light of earlier similar analyses of British Columbia data (Evans and Walker 1972, Barer 1981). In light of our earlier discussion of the expected role of SPCLC1 and the fact that Table 9 shows that variable to have been strongly significant over the entire six-year period, it too may have played a part in reducing the significance of CMPADJ.

Since we were unable to establish any convincing a priori case for the effect of SPCLC1, the strength of this variable also came as a surprise. We can only suggest again that the larger hospitals displaying high SPCLC1 values, which were large enough to have treated a wide range of cases but have been designated to play specific roles in the health care delivery system of Ontario, dominated the SPCLC1 effect. Apparently their type of specialization involves a high degree of resource-intensive care.[5] In addition, the hospital with the highest SPCLC1 value for this particular data set also had the highest CMPXC1 value. Since its SPCLC1 value was so large as to represent a significant share of the total variance in that variable, this may also be partially responsible for the unexpectedly low significance of the CMPXC1 variable.[6]

The impact of SPCLC1 on CASEXD, however, seems somewhat less than that of CMPADJ. The range of hospital-specific mean SPCLC1 values was 0.29 to 14.3. The majority of the hospitals' SPCLC1 measures, however, were in the much narrower 0.3 to 2.5 range. Two hospitals identical in all respects save SPCLC1 value (1.0 versus 1.5) could be expected to report CASEXD values about $10 apart, with the higher-SPCLC1 hospital of course having the higher CASEXD figure.

4 In contrast, Appendix D illustrates that case complexities averaged over the six years ranged from about 0.50 to over 4.0 for the 237 diagnostic categories.

5 In fact, as mentioned earlier, the two hospitals with the highest SPCLC1 values were the Princess Margaret Hospital (for cancer) and the Orthopaedic and Arthritic Hospital.

6 This suggests an extension to this analysis: a re-estimation of the parameters after the elimination of this particular hospital from the data set, or after the insertion of an interactive SPCLC1 dummy to segregate that particular hospital.

The parameter estimates on the WAGE variable have the expected sign and are strongly significant in all six years. This not surprisingly supports the contention that, other things being equal, high-wage hospitals will have higher case costs. A hospital with a wage level 10 per cent higher than the provincial average would have been expected to incur case costs anywhere from $13.55 higher (in 1973) to $24.35 higher (1974) than the provincial average value in each year.

The parameter estimates on the factor scores generally agree with our hypotheses. As expected, the factor representing the aged (75+), F_1, has a strong positive influence on CASEXD variance, and F_2, the 14-and-under variable, not surprisingly shows significant negative parameter estimates. F_3, which in 1969, 1970, 1972, and 1973 loaded strongly on men in the 50-74 age group, and $F4$, which took over from F_3 in that representation in the remaining years, exert the expected significant positive influence on CASEXD in their respective years. When F_3 and F_4 correlated with the proportions of male patients in the 20-49 age group (1971 and 1974 for F_3; the other four years for F_4), the impact was mixed – but only significant in the negative direction (F_3 in 1974, F_4 in 1972).

For the factor score representing women aged 45-64, F_5, the parameter estimates were positive and significant in five of the six years, confirming that hospitals treating a disproportionately high number of patients in this age-sex category will, other things being equal, have high costs per case. No immediate explanation presents itself for the sudden insignificance of F_5 in 1974. As noted earlier, F_7 captured the impact of the 15-19 age group proportions in 1970-72 only, and the negative significant parameter estimates in those years are not surprising. Hospital treatment for that age group will generally be of the short-stay variety for non-complex diagnoses.

A similar analysis of results for DAYEXD yields similar conclusions. The only area where parameter significance departed markedly from the pattern shown in the CASEXD equation is the factor scores, and those departures are not unexpected. However, turning first to the case flow/scale variables, the signs on both B/D and B^2/D are as expected: positive and strongly significant, although the former and the WAGE variable seem to lose some of their significance to EDRAT in 1974. It should be remembered that $B/D = 1/(3.65 \cdot \text{OCC})$, so that the parameter for B/D translates directly into the impact of OCC on DAYEXD. The mean value for the parameter estimate on B/D is 1953, and for that on B^2/D, 2.305. If we return to our fictitious 500-bed hospital with 16,000 separations, an occupancy rate of 80 per cent and an approximate ALS of 9.125 days,[7] we can again work through the cost implications of combinations of changes in B and D. The value

7 ALS will only equal 9.125 days if $D =$ SDS (separated days stay). But for the purpose of these and the previous examples, the arguments are not compromised by this simplification.

of D for this hospital is 16,000 times $9.125 = 146{,}000$ days. Let us first assume an increase of 5 per cent in D with no concurrent increase in bed capacity. The aggregate effect on DAYEXD would be a decline of $0.51. This increase in D could result from a 5 per cent increase in C with ALS held constant or an increase in ALS to 9.58 days with C unchanged, or some combination of changes in C and D. If it results from the increase in C, ALS unchanged, then an increase in OCC from 80 per cent to 84 per cent is implied, and we can compare its influence on DAYEXD with the influence of the comparable combination of variable shifts on CASEXD. Recall that the aggregate influence on CASEXD of a 5 per cent increase in each of C and OCC (ALS constant) was a decline of $4.56. If we take our DAYEXD decline of $0.51 and multiply it by the ALS of 9.125 days, the implied change in CASEXD is a reduction of $4.65. This degree of consistency between the two equations is most encouraging.

Other combinations may be explored in the same way as for the CASEXD equation. Shifts in B and D of offsetting magnitudes will only affect B^2/D. Thus if there is a 5 per cent decline in D as a result of an identical tightening of bed capacity, the fictitious hospital would take on measurements of 475 beds and 138,700 days. The effect on DAYEXD would be an almost negligible $0.20 reduction. A reduction in rated bed capacity to 475 beds with no concurrent decline in D would naturally increase OCC to 84.2 per cent and induce a $0.71 fall in DAYEXD. In general, the source of a change in D, whether separations, length of stay, or both does not affect its impact on B/D, because ALS was found to be an insignificant factor in independently explaining variation in DAYEXD. That is in contrast to the CASEXD equation, where an ALS-induced increase in D would work through OCC, while a C-induced increase in D would influence CASEXD through B/C and B^2/C only (if ALS was unchanged).

Among the other variables, the pattern exhibited by the EDRAT parameter mirrors that in the CASEXD equation, probably for precisely the same reasons. The size of the increase in DAYEXD as a result of an increase in EDRAT from 0.05 to 0.06 would be $0.45 using the 1974 estimate, slightly less than the proportional impact of that change on CASEXD.[8]

The importance of relative wage levels in explaining variation across hospitals in DAYEXD is also comparable to that of WAGE in explaining CASEXD variation. The hospital with wage levels 10 per cent higher than the provincial average may be expected to report inpatient per diem $2.00 to $2.80 higher than

8 Recall that the provincial average CASEXD in 1974 was 442.08, while the corresponding DAYEXD value was 48.34. Therefore the result of that 20 per cent increase in EDRAT would be an approximate 0.9 per cent increase in DAYEXD as compared to a 1.2 per cent increase in CASEXD.

average. What is somewhat puzzling is the divergence of WAGE parameter trends in 1974. While WAGE in CASEXD takes a significant jump, in DAYEXD it falls to a level 30 per cent lower than its value in the other five years.

It was expected that CMPADJ would be a positive and significant force in explaining variation of both CASEXD and DAYEXD but that it would be more significant in DAYEXD because of the absence of any ALS influence. Indeed, that is what the results indicate. The magnitude and significance of the CMPADJ variable are relatively stable, and the parameter estimates imply that, other things being equal, an increase in CMPADJ from 0.80 to 1.00 would cause inpatient per diems to rise by as much as $4.13. SPCLC1 also retains a positive significant impact on DAYEXD, again probably because of the two high-technology hospitals. Applying the same comparison of 1.0 and 1.5 values for SPCLC1 as was used with CASEXD, the difference in DAYEXD would run about $0.45.

Finally we come to the factor scores. Early in this chapter it was suggested that we might expect negative and positive parameter estimates respectively for F_1 and F_2, but little more than educated guesses were possible about the effect of the other factor scores on DAYEXD. The negative coefficient that was expected for F_1 is borne out, but the parameters are never significant at a 5 per cent confidence level. Similarly, the F_2 parameter estimate is positive, as expected, but significant only in 1973. The only other significant coefficients among the factor scores appear on F_6 in 1970 and 1971. No explanation can be offered because of the absence of any translatable pattern in the loadings for that factor. In short, age-sex patient mix is far less important a factor in explaining DAYEXD variation than CASEXD variation. That is not surprising either, but the general lack of significance of the factor scores in the DAYEXD equation relative to the CASEXD equation is quite likely responsible for a considerable share of the discrepancy in $\bar{R}^2$ values for the two sets of equations.

The original intention was to use the parameter estimates from Tables 9 and 10 as the basis for the 'simulation' to generate diagnosis-specific marginal cost estimates. Unfortunately, simulations based on the model described here proved to be impractical owing to the theoretical construction of the SPCLC1 variable and the very real constraints on the computer budget available to this study. The first segment of the following chapter is devoted therefore to detailing the problem and to reporting on a re-specification of these two equations.

5
The derivation of diagnosis-specific costs

Chapters 3 and 4 have described the specification and estimation of two equations relating hospital inpatient costs to a number of basically exogenous variables. The parameter estimates from those equations were to become the parameters in a simulation model that would estimate the diagnosis-specific and hospital-specific inpatient marginal costs, both per day and per case. However, a problem with the SPCLC1 variable (noted at the end of Chapter 4 and described below) precluded their use.

The marginal costs are estimated by considering the implications of changing each hospital's case mix by altering its number of separations in one diagnostic category at a time. For example, consider a hospital that reports twenty-five separations for which the recorded principal diagnosis is infectious hepatitis (our adjusted OBC code 13), and assume that the yearly hospital case load was 10,000 separations. The simulation estimates the effect on CASEXD and DAYEXD if this hospital had instead treated and discharged three (10 per cent of twenty-five)[1] fewer hepatitis cases during the year, other things being equal. This small change in the hospital's case mix would increase the values of B/C and B^2/C and would change the value of CMPADJ (depending on the case complexity of infectious hepatitis in relation to that hospital's complexity value) and the value of SPCLC1 (depending on the hospital's proportion of infectious hepatitis cases compared to the provincial proportion). OCC would decrease, and theoretically F_1 to F_8 would also change. In the DAYEXD equation, B/D, B^2/D, CMPADJ, SPCLC1, and F_1 through F_8 would shift.

1 The choice of 10 per cent to represent 'marginal' changes was arbitrary but was subjected to a certain amount of sensitivity analysis, with no significant alterations in the marginal cost magnitudes.

A number of assumptions have had to be made for present purposes. EDRAT and WAGE were assumed not to shift in response to these small case-mix changes. It is not unrealistic to assume that any influence of educational activity on inpatient care will continue to be represented by the same proportion of total operating expenditures. In any case, the size of the change in this variable would be difficult to determine. One could otherwise have assumed that aggregate education expenditure would not change, so that EDRAT would rise in response to any reduction in case load, but this effect would be expected to be diagnosis-invariant at the margin and would thus not affect the relative sizes of the marginal costs. Therefore an assumption of unchanged EDRAT values was made.

Similarly, no convincing case could be made for changes in WAGE, so that it too was assumed to be unchanged for each hospital. The factor scores, F_1 to F_8, will by definition change values whenever there is a shift in case mix of even one separation since that would alter the age-sex distribution of the hospital's separations. However, the only information that could be used in estimating the new distribution would be the relationship of the particular diagnosis-specific age-sex structure to that of the hospital as a whole. But the original age-sex data were compiled only on a hospital-specific basis. To re-assemble the data for each year by hospital and diagnosis would have entailed the creation of six (one per year) three-dimensional arrays with 1,897,896 entries each (182 times 237 times 44). When measured against the expected information gain from this exercise, the costs of data manipulation and storage would clearly have been prohibitive. Consider for example the complexity and time needed for a computer program that, for each case in each year in each hospital (182 times 6 times 237 = 258,804 times) re-calculated the age-sex proportion matrix and computed the resulting factor scores. Even with diagnosis-specific proportions, assumptions would have to be made about which age-sex categories would absorb the small reductions in number of separations. Accordingly, F_1 through F_8 were assumed not to change value.

But the most critical problem was posed by the SPCLC1 variable. While case-mix changes at the margin will alter its value, to recompute it for each diagnosis, hospital, and year would also require a great deal of computer time. The variable is defined as

$$\text{SPCLC1} = \sum_j p_{ij} \cdot ln \frac{p_{ij}}{Q_j} \Big/ \sum_i \Big(\sum_j p_{ij} \cdot ln \frac{p_{ij}}{Q_j}\Big) \cdot P_i ,$$

where all notation is as described in the SPCLC1 discussion of Appendix A. Recall in particular that $Q_j = C_j/C$ represents the jth diagnosis proportion of all provincial separations. Since Q_j will then change whenever even one case of any

type in any hospital is dropped, to recompute SPCLC1 for that hospital would entail recomputing the denominator. But the denominator includes a nested summation and must be summed over all hospitals and all cases. The first stage of our marginal cost estimation was the derivation of 237 marginal costs for each of 182 hospitals in each of six years. Computation of the denominator itself requires 237 times 182 additions (not to mention the multiplications and divisions).

Since it was not feasible in this study to allow SPCLC1 to vary with changes in case mix, the question was whether to assume that it remained constant as with the factor scores (despite its construction, which is based directly on case mix) or to re-estimate the model without SPCLC1 and run the simulation using the resulting parameters. The latter approach was adopted because it was thought that the former would underrepresent the impact of case-mix changes. The removal of the variable allowed other variables that do shift in the simulation to capture at least some of the effect embodied in SPCLC1.[2] In short, while the equations used for the simulation may be underspecified in terms of explaining the behaviour of hospital cost variance, they seem more useful for simulation purposes than the fully specified equations in which SPCLC1 is held constant. Finally, some trial results obtained by running the simulation with SPCLC1 and the Table 9 estimations were not markedly different from those based on the equation without SPCLC1.

Tables 11 and 12 report the results from re-estimating the CASEXD and DAYEXD equations without the SPCLC1 variable. A cursory comparison of the parameters contained in them with those of Tables 9 and 10 shows slightly more than a 10 per cent drop in the $\bar{R}^2$ values for the CASEXD specification and a smaller 6 to 7 per cent drop for DAYEXD. The explanatory power of both equations is still quite satisfactory. With respect to specific variables, B/C gains in significance, while B^2/C becomes less significant. The discontinuous pattern of the EDRAT parameter as a result of the transfer of nursing education out of hospitals shows up much more vividly in this re-specification. CMPADJ, F_1 and F_5 all gain slightly in significance. In the DAYEXD equation, B/D gains marginally, while B^2/D loses marginally, in parameter significance. Again CMPADJ becomes more important, but in general the changes in parameter estimates are of little consequence.

2 This process was admittedly arbitrary. One could have also argued for the removal of F_1 to F_8. But whereas changing the value of F_1 to F_8 would have in turn required a somewhat arbitrary allocation of case load reduction across age-sex classes, SPCLC1 was by definition linked precisely to any changes in case mix.

TABLE 11

Maximum likelihood estimation 2, dependent variable CASEXD

	1969	1970	1971	1972	1973	1974
B/C	4412.7	4070.7	4162.1	4672.1	4489.9	5657.6
	(10.81)	(10.87)	(11.40)	(12.23)	(10.67)	(14.40)
B^2/C	3.381	2.854	2.984	2.700	2.504	2.271
	(8.26)	(6.57)	(6.89)	(5.29)	(4.44)	(3.59)
OCC	90.10	82.71	89.07	111.5	124.1	135.3
	(4.38)	(4.07)	(5.11)	(5.59)	(5.45)	(5.13)
EDRAT	50.29	74.21	65.42	–38.71	164.1	480.7
	(0.57)	(0.90)	(0.81)	(0.53)	(1.75)	(3.42)
WAGE	194.1	141.9	148.4	158.2	158.6	271.5
	(4.80)	(3.57)	(3.90)	(4.33)	(3.89)	(5.35)
CMPADJ	114.8	66.24	95.86	158.4	39.73	2.529
	(2.56)	(1.96)	(2.74)	(4.64)	(1.19)	(0.07)
F_1	15.35	18.6[illegible]	21.11	17.78	17.02	23.07
	(4.33)	(5.60)	(5.98)	(5.17)	(4.56)	(5.21)
F_2	–7.939	–10.03	–8.003	–8.271	–6.588	–7.431
	(2.39)	(3.02)	(2.59)	(2.58)	(1.84)	(1.81)
F_3	19.16	12.54	1.045	16.55	15.30	–6.087
	(5.51)	(3.46)	(0.46)	(5.34)	(4.18)	(2.08)
F_4	3.099	1.627	15.28	–4.122	–0.113	12.50
	(1.23)	(0.64)	(4.96)	(1.90)	(0.05)	(3.16)
F_5	15.35	15.21	13.73	12.35	11.82	4.492
	(5.21)	(5.72)	(5.93)	(5.50)	(4.59)	(1.39)
F_6	–5.076	0.611	0.906	–3.100	5.102	–2.765
	(2.30)	(0.34)	(0.56)	(1.73)	(2.27)	(0.99)
F_7	2.804	–5.801	–7.331	–5.249	–1.688	1.743
	(1.44)	(2.66)	(3.55)	(2.65)	(0.92)	(0.90)
F_8	1.286	2.906	–1.456	0.616	0.927	0.752
	(0.77)	(1.78)	(1.01)	(0.48)	(0.52)	(0.32)
Constant	–146.0	–32.37	–70.95	–160.6	–61.62	–173.4
$\bar{R}^2$	0.782	0.702	0.733	0.717	0.677	0.716
SEE	67.21	76.01	73.31	75.97	80.30	88.10

NOTE: t-statistics in parentheses

With this revised set of independent variables the case mix changes would induce changes in the values of B/C, B^2/C, OCC, and CMPADJ in the CASEXD equation, and B/D, B^2/D and CMPADJ in the DAYEXD equation. Six different marginal cost measures were derived. The first, denoted hereafter by MCC1, represents the marginal inpatient cost per case estimated from diagnosis-specific case mix changes, bed supply remaining constant. MCD1 represents the corresponding estimates of marginal cost per day. Since the aim of this project was to apply these marginal costs in assessing the potential impact of commun-

TABLE 12

Maximum likelihood estimation 2, dependent variable DAYEXD

	1969	1970	1971	1972	1973	1974
B/D	2465.1	2895.1	2511.3	1548.8	1831.9	1265.7
	(8.14)	(11.92)	(11.26)	(5.75)	(7.82)	(3.89)
B^2/D	1.603	1.669	1.962	1.843	2.428	2.136
	(3.74)	(3.80)	(5.07)	(4.13)	(5.27)	(4.47)
EDRAT	2.838	7.399	7.580	–3.922	4.792	42.96
	(0.37)	(1.60)	(1.23)	(0.57)	(0.57)	(3.39)
WAGE	28.20	26.62	28.19	28.45	28.82	21.34
	(8.13)	(7.98)	(9.21)	(7.99)	(8.38)	(4.85)
CMPADJ	20.59	16.91	16.97	24.97	17.65	15.31
	(5.88)	(6.38)	(6.40)	(8.63)	(6.72)	(5.45)
F_1	–0.308	–0.247	–0.082	–0.013	–0.240	–0.231
	(1.31)	(1.04)	(0.35)	(0.05)	(0.91)	(0.75)
F_2	0.224	0.307	0.270	0.286	0.615	0.524
	(0.88)	(1.23)	(1.14)	(1.06)	(2.13)	(1.65)
F_3	0.277	–0.023	0.115	0.630	0.497	0.147
	(1.09)	(0.08)	(0.69)	(2.34)	(1.76)	(0.63)
F_4	0.246	–0.014	0.366	–0.050	0.172	0.055
	(1.30)	(0.08)	(1.55)	(0.26)	(0.88)	(0.18)
F_5	0.471	0.323	0.259	0.499	0.434	0.586
	(2.25)	(1.64)	(1.46)	(2.50)	(2.12)	(2.31)
F_6	–0.365	–0.253	–0.232	0.118	–0.066	0.104
	(2.02)	(1.76)	(1.78)	(0.71)	(0.35)	(0.46)
F_7	–0.014	–0.368	–0.032	–0.066	–0.089	0.036
	(0.09)	(2.31)	(0.207)	(0.37)	(0.57)	(0.21)
F_8	–0.092	–0.133	–0.005	0.026	0.063	0.019
	(0.70)	(1.12)	(0.049)	(0.21)	(0.44)	(0.10)
Constant	–16.88	–13.22	–12.84	–15.40	–9.55	2.50
$\bar{R}^2$	0.605	0.598	0.594	0.607	0.571	0.557
SEE	3.98	4.24	4.29	4.65	4.98	5.21

NOTE: t-statistics in parentheses

ity health centres on hospital expenditures, and since it is widely acknowledged that any such savings will occur only if the freed beds remain empty (which is unlikely), a second set of marginal cost figures was estimated. MCC2 represents the estimated marginal inpatient costs per case resulting from assuming bed stock adjustments concurrent with the diagnosis-specific reductions in case mix. In particular, it was assumed that bed supply shifted with the case mix reduction so as to retain a constant hospital occupancy rate. MCD2 is again the marginal inpatient per diem equivalent.

There is one other way of estimating marginal costs. In addition to working through the impact of a change in case mix on costs, we also derived the per diem

implications of reductions in length of stay, with case mix assumed unchanged. This procedure did not, of course, generate 182 times 237 additional marginal cost figures for each year, since the diagnosis for which the length of stay was reduced was irrelevant. Any decline in ALS with case mix and bed stock unchanged leads to reductions in B/D and B^2/D only. The impact on DAYEXD is then diagnosis-invariant. The result of this segment of the analysis was two figures for each hospital in each year – MCD3, representing the marginal cost per day resulting from declines in ALS only, and MCD4, in which bed supply was assumed to adjust with the reduction in ALS so as again to impose an unchanged occupancy rate.

The derivation of the six measures can perhaps best be illustrated with an example. Using the fictitious 500-bed, 16,000 case hospital of Chapter 4, let us assume that in 1974 it treated thirty cases of infectious hepatitis. Assume further that the hospital's complexity value was 1.20, that the case complexity of infectious hepatitis is 1.004 (see Table D.2), and that the average length of stay for hepatitis patients in this hospital was 12.3 days.[3] When the simulation reached this hospital and this case type, the hospital's total of hepatitis separations would first be reduced by 10 per cent to twenty-seven cases. This would result in B/C increasing from 0.03125 to 0.31256, and B^2/C from 15.625 to 15.62793. It would then be assumed that the three 'saved' cases incurred lengths of stay averaging 12.3 days, so that the hospital's ALS would fall from 9.125 to 9.1244 and its occupancy rate from 0.80 to 0.7998. Since the hepatitis case complexity is lower than this hospital's case-mix complexity, the elimination of three such cases would cause a slight increase in the hospital's CMPADJ value.[4] At this stage, then, revised values of B/C, B^2/C, OCC, and CMPADJ are in hand. The estimated value of CASEXD, using the hospital's actual values for all the independent variables, denoted by $\widehat{\text{CASEXD}}$, is easy to compute. The new values of the four independent variables noted above allow the estimation of a revised, estimated CASEXD value, $\widehat{\text{CASEXD}}_n$. Then, letting $\widehat{\text{IPEXP}} = \widehat{\text{CASEXD}} \cdot C$ and denoting the subtracted cases by NC(= –3 in this case), we have $\widehat{\text{IPEXP}}_n$

3 This was the provincial average length of stay for infectious hepatitis cases in 1974 (Ontario n.d. 1976c, 73).

4 Strictly speaking, changing even one hospital's case mix in this relatively insignificant way will alter all the individual *case* complexities, because their construction is based on the provincial dispersion of all separations. Unfortunately, the recomputation of all 237 case complexities, 182 × 237 × 6 times, posed problems similar to those described above for SPCLCI. The assumption of invariant case complexities was quickly deemed the lesser of two evils. Besides, any bias introduced by that assumption can be checked. The value of $\Sigma_j \bar{H}_j Q_j$ which should equal 1.0 by construction (see Appendix A) was checked throughout the simulation on each iteration. Not once did it exceed an absolute deviation of 0.0003 from 1.0.

$= \widehat{\text{CASEXD}}_n \cdot (C + \text{NC})$ and $\text{MCC1}_{ij} = (\widehat{\text{IPEXP}}_n - \widehat{\text{IPEXP}})/\text{NC}$, where i is our fictitious hospital and j is infectious hepatitis in this instance.

The per diem equivalent, MCD1, would be computed for this hospital and case type in a similar manner. B/D would increase from 0.003425 to 0.003426, B^2/D from 1.712329 to 1.712762, and the qualitative change in CMPADJ would be as described above. Again, $\widehat{\text{IPEXP}}$ would be computed as $\widehat{\text{IPEXP}} = \widehat{\text{DAYEXD}}_n \cdot (D + \text{ND})$, where ND is equal to NC times the average length of stay for the jth diagnosis, and $\text{MCD1}_{ij} = (\widehat{\text{IPEXP}}_n - \widehat{\text{IPEXP}})/\text{ND}$.

When rated bed capacity is assumed to adjust so as to maintain a constant occupancy rate, the B/C value for our representative hospital would become 0.031248, B^2/C would fall to 15.62003, OCC would be unchanged, CMPADJ would adjust as for MCC1, and the resulting MCC2_{ij} would be larger than MCC1_{ij}. For MCD2, recall that B/D is directly and inversely proportional to OCC, so that bed adjustment to maintain a constant value of OCC imposes constancy on B/D. Thus, a drop in B^2/D to 1.711896 (originally 1.712329) and the change in CMPADJ identical to the one made in the MCD1 calculation are the only changes in independent variables underlying the MCD2 estimates.

The marginal cost estimates resulting from changes in length of stay, case mix unchanged, have already been described. In this example, a 10 per cent reduction to 11.1 days in average length of stay for hepatitis patients would result in increases both to B/D and B^2/D, but no change in CMPADJ. Since the thirty cases of hepatitis entailed 369 aggregate days stay, the shortened length of stay reduces this to 333 days, implying an increase in B/D from its original value of 0.003425 to 0.003426, and in B^2/D from 1.712329 to 1.712751. When bed stock adjusts to retain OCC constancy, B/D is unchanged, but B^2/D falls to 1.711902.

The output from this simulation was four 237-element arrays (for MCC1, MCC2, MCD1, and MCD2), as well as two single figures (MCD3 and MCD4), for each hospital and each year. To report here the results from this stage of the simulation would serve little purpose.[5] The second phase of the marginal cost analysis consisted of aggregating the results across hospitals for each year. Thus, the year- and case-specific marginal costs, SMCC1_{jt}, were constructed as

$$\text{SMMC1}_{jt} = \sum_{i=1}^{182} \text{MCC1}_{ijt} \cdot c_{ijt} / C_{jt},$$

where C_{jt} denotes total provincial discharges of diagnostic class j in year t and c_{ijt} is the number of discharges of that type in the ith hospital in the same year. The

5 Hospital-specific results are available from the author.

importance of each hospital's marginal cost is determined by its share of the total provincial caseload for each diagnosis. The same weights were applied in aggregating hospital-specific MCC2, MCD1, and MCD2 values. SMCD3 and SMCD4 were derived using hospital-specific proportions of total provincial caseload as weights:

$$\text{SMCD}3_t = \sum_{i=1}^{182} \text{MCD}3_{it} \cdot C_{it} / C_t ,$$

where C_t was total provincial discharges in year t. By the conclusion of this stage, the volume of results was beginning to be manageable – six 237-element arrays for each of SMCC1, SMCC2, SMCD1, and SMCD2, and six single numbers representing the yearly aggregated values for SMCD3 and SMCD4.

The final stage consisted of aggregating across the six years to obtain a single marginal cost value for each of $\text{MCC}1_j$, $\text{MCC}2_j$, $\text{MCD}1_j$, and $\text{MCD}2_j$, and single MCD3 and MCD4 values. Here the aggregation weights were yearly proportions of six-year case totals. Thus

$$\text{SSMCC}1_j = \sum_{t=1}^{6} \text{SMCC}1_{jt} \cdot C_{jt} / C_j ,$$

where $C_j = \sum_{t=1}^{6} C_{jt}$, and $\text{SSMCC}2_j$, $\text{SSMCD}1_j$, and $\text{SSMCD}2_j$ were similarly computed. SSMCD3 became

$$\text{SSMCD3} = \sum_{t=1}^{6} \text{SMCD}3_t \cdot C_t / C,$$

where $C = \sum_{t=1}^{6} C_t$, and SSMCD4 involved an analogous construction.

Table 13 represents the culmination of the three stages of marginal cost estimation and aggregation. The results warrant both general and diagnosis-specific comments. As expected, the marginal costs based on concurrent reductions in caseload and in bed stock exceed those based only on caseload adjustments. The elimination of beds with their associated fixed costs clearly increases the potential savings inherent in a reduction in inpatient throughput. The weighted mean value for SSMCC $\sum_{j=1}^{237} \text{SSMCC}1_j \cdot (C_j / C)$, was \$324.84, approximately 74 per cent of the weighted average of the CASEXD values

TABLE 13

Diagnosis-specific marginal costs (dollars)

Diagnostic category	SSMCC1	SSMCC2	SSMCD1	SSMCD2
1	420.37	626.20	43.16	55.00
2	266.67	340.42	25.44	36.50
3	298.02	407.79	28.80	39.98
4	447.80	771.58	39.51	52.70
5	364.28	506.17	41.95	54.23
6	306.21	377.37	38.46	48.87
7	401.77	612.50	44.08	57.08
8	438.49	761.63	47.35	62.17
9	364.57	477.35	65.79	79.11
10	291.32	394.55	28.80	40.56
11	364.14	557.74	42.04	53.94
12	260.93	332.56	21.63	32.60
13	346.13	521.58	31.55	43.62
14	310.66	402.75	42.14	54.66
15	278.48	379.65	23.35	35.44
16	322.16	473.98	29.91	41.96
17	514.88	774.69	56.28	69.02
18	454.86	763.05	34.12	46.42
19	480.25	824.42	33.87	45.97
20	496.69	841.49	35.30	47.53
21	470.98	799.72	35.69	48.15
22	461.42	752.94	39.86	53.03
23	507.96	801.37	56.10	69.75
24	505.78	823.90	47.28	59.85
25	395.77	563.53	46.15	58.80
26	428.31	648.48	39.97	52.13
27	514.81	701.87	63.89	75.49
28	432.69	618.38	45.64	58.04
29	473.77	696.03	48.23	60.01
30	527.10	853.55	53.32	66.22
31	430.35	701.33	35.40	47.77
32	456.20	655.32	56.44	68.48
33	423.60	644.58	41.75	54.16
34	488.43	810.11	41.20	53.80
35	568.70	992.90	49.08	63.12

TABLE 13 continued

Diagnostic category	SSMCC1	SSMCC2	SSMCD1	SSMCD2
36	448.99	733.15	37.71	50.27
37	439.85	652.61	50.92	64.31
38	487.83	699.76	59.47	72.67
39	275.05	315.69	36.59	48.10
40	283.94	343.08	43.55	55.62
41	326.34	430.08	34.45	45.93
42	317.54	422.90	32.27	43.88
43	271.80	328.88	25.92	37.31
44	425.63	701.93	50.95	65.09
45	301.11	401.98	33.40	45.58
46	346.48	452.61	39.76	51.43
47	347.33	497.94	39.97	52.73
48	398.63	597.35	43.89	57.58
49	335.46	455.70	37.69	50.15
50	359.28	544.02	34.32	46.88
51	347.14	537.05	28.34	39.84
52	379.45	569.20	43.11	56.62
53	348.17	526.18	34.26	46.37
54	466.86	733.37	65.64	80.63
55	351.86	552.68	31.44	43.75
56	346.47	528.32	30.28	42.15
57	383.62	609.51	30.02	41.46
58	299.24	416.26	30.72	42.68
59	378.35	568.20	38.16	50.18
60	540.53	929.48	44.60	57.29
61	426.15	720.12	34.24	45.71
62	447.58	770.22	37.07	49.71
63	365.82	577.42	32.18	43.85
64	320.49	438.34	33.43	44.48
65	386.27	555.37	54.92	67.63
66	387.74	591.86	40.68	53.28
67	435.14	639.27	59.44	73.09
68	413.57	665.70	46.59	60.26
69	468.65	758.47	56.46	71.10
70	470.41	807.40	36.99	49.95
71	470.04	825.62	33.57	45.90

TABLE 13 continued

Diagnostic category	SSMCC1	SSMCC2	SSMCD1	SSMCD2
72	303.82	437.94	28.61	40.80
73	392.55	630.08	43.27	56.87
74	451.80	787.80	39.76	53.17
75	332.75	484.72	33.49	46.00
76	323.92	431.89	37.80	49.14
77	349.37	463.02	49.84	62.97
78	335.25	370.98	109.78	122.94
79	400.34	532.71	52.36	65.36
80	392.47	532.58	53.41	67.10
81	401.20	524.85	71.19	85.66
82	282.83	341.36	36.28	48.29
83	376.00	489.73	57.36	69.76
84	333.46	406.03	53.53	66.42
85	362.23	587.17	29.61	41.17
86	477.71	775.67	49.74	64.74
87	317.80	474.37	26.45	37.95
88	408.39	651.07	31.01	42.44
89	363.08	552.04	30.47	42.03
90	352.15	540.78	29.27	41.01
91	369.76	596.65	31.88	44.08
92	448.51	753.33	35.20	47.80
93	412.18	674.70	30.75	42.26
94	419.08	688.69	31.51	43.22
95	437.91	692.71	49.37	63.18
96	481.41	817.09	40.41	53.84
97	431.18	681.59	36.70	49.21
98	352.04	539.00	29.02	40.39
99	387.96	611.42	34.95	47.23
100	321.61	434.54	31.75	43.29
101	302.07	393.69	29.89	41.10
102	336.63	496.63	33.99	46.52
103	359.68	528.26	34.51	46.82
104	259.09	322.77	22.82	33.54
105	260.21	331.65	19.00	28.57
106	299.82	431.28	25.50	36.39
107	280.42	387.81	23.74	34.55
108	356.45	549.02	28.08	38.74
109	287.80	388.02	28.61	40.17
110	243.30	265.80	24.65	36.08

TABLE 13 continued

Diagnostic category	SSMCC1	SSMCC2	SSMCD1	SSMCD2
111	311.27	386.46	43.38	55.50
112	343.07	397.36	74.80	87.26
113	311.51	379.55	49.99	63.03
114	455.99	799.02	39.38	52.41
115	379.63	590.63	34.97	47.85
116	323.37	476.56	27.61	39.28
117	367.46	559.07	33.91	46.33
118	246.30	267.23	37.79	48.53
119	275.28	352.87	26.45	38.47
120	358.72	525.28	39.29	52.19
121	378.01	586.55	31.25	42.83
122	346.47	513.70	29.63	40.94
123	305.02	439.86	24.06	34.58
124	392.19	611.63	31.64	43.31
125	262.76	342.28	19.66	30.13
126	302.45	438.37	25.85	36.95
127	280.08	360.28	26.21	37.38
128	298.69	395.95	29.17	40.59
129	325.60	449.35	30.59	41.97
130	343.72	517.29	30.28	42.02
131	279.60	389.57	28.50	40.03
132	412.91	674.31	35.56	48.12
133	353.88	530.57	29.68	40.90
134	307.16	432.80	28.20	39.77
135	422.94	683.26	33.98	46.17
136	375.30	596.87	32.82	45.06
137	345.97	493.04	31.38	42.67
138	319.15	454.25	27.62	38.61
139	336.05	508.94	27.63	38.65
140	360.49	544.96	32.65	44.59
141	465.66	519.52	252.27	266.56
142	293.63	419.33	23.88	35.26
143	397.88	616.90	39.59	52.51
144	321.60	433.18	34.22	46.26
145	289.65	377.07	29.74	41.24
146	391.99	591.09	42.65	55.36
147	350.10	444.43	57.28	69.50
148	334.59	455.12	39.15	51.50
149	409.19	622.76	38.39	50.92

TABLE 13 continued

Diagnostic category	SSMCC1	SSMCC2	SSMCD1	SSMCD2
150	254.82	287.00	29.54	40.53
151	282.57	364.52	27.38	39.02
152	269.95	322.18	29.36	41.08
153	315.25	414.95	32.62	44.32
154	290.44	349.80	34.18	44.89
155	266.41	326.80	23.21	34.49
156	361.25	510.72	34.35	45.91
157	309.42	389.42	35.39	46.23
158	269.66	319.18	28.41	39.68
159	287.25	354.77	31.02	42.41
160	289.01	356.64	30.34	41.75
161	262.38	320.60	21.45	32.47
162	257.47	294.28	25.78	37.10
163	288.95	363.57	29.17	40.41
164	308.25	350.31	63.92	76.95
165	295.91	366.66	33.05	44.39
166	354.54	474.63	39.37	51.17
167	398.53	529.16	47.03	59.39
168	359.45	448.70	47.67	59.42
169	359.09	469.83	41.46	53.17
170	359.95	469.04	43.48	55.53
171	259.53	304.04	22.81	34.21
172	352.25	439.88	48.91	59.30
173	304.55	388.47	32.21	43.68
174	280.91	393.70	23.74	35.30
175	320.22	489.01	28.54	40.52
176	299.88	417.39	29.17	41.08
177	472.19	821.63	38.92	51.34
178	415.16	697.83	35.02	47.47
179	314.15	477.15	25.90	37.08
180	394.19	637.82	35.82	48.49
181	386.89	599.91	34.15	46.11
182	324.68	442.45	35.71	47.98
183	266.03	325.75	26.75	37.95
184	338.29	475.69	38.63	51.13
185	599.84	1062.55	75.49	90.62
186	522.11	844.33	67.87	82.71
187	403.25	520.64	90.56	104.92
188	333.38	387.87	83.00	96.17

TABLE 13 continued

Diagnostic category	SSMCC1	SSMCC2	SSMCD1	SSMCD2
189	520.23	765.92	81.20	97.32
190	585.30	897.56	82.92	99.79
191	502.91	756.77	82.74	98.89
192	444.34	614.84	80.09	94.98
193	490.19	645.72	105.39	120.86
194	456.27	628.85	83.08	98.04
195	380.14	579.05	47.06	59.89
196	343.14	463.64	45.34	58.18
197	367.45	483.46	55.96	69.00
198	425.74	629.09	54.55	68.47
199	346.86	487.29	47.46	60.62
200	321.75	467.30	27.93	41.23
201	382.55	490.08	54.66	66.78
202	427.21	628.22	55.63	68.99
203	393.80	520.68	54.14	66.92
204	490.67	746.27	57.53	71.00
205	419.92	533.56	60.14	72.59
206	274.47	334.14	36.41	48.64
207	292.78	366.26	36.25	48.47
208	360.66	532.26	47.28	60.67
209	316.04	416.36	38.97	51.47
210	316.38	426.26	38.72	51.27
211	384.20	624.27	30.03	41.42
212	259.53	330.97	20.78	31.94
213	552.93	995.17	34.27	46.37
214	333.08	496.25	28.79	40.18
215	270.79	367.94	21.68	32.92
216	255.07	315.52	21.67	33.09
217	476.10	817.33	55.47	70.18
218	344.59	514.65	31.14	42.84
219	229.73	284.14	7.87	18.53
220	309.32	401.03	38.90	51.13
221	267.44	319.65	32.07	43.12
222	416.11	712.79	34.75	46.59
223	249.89	314.88	17.62	28.62
224	241.42	306.57	14.09	24.58

TABLE 13 continued

Diagnostic category	SSMCC1	SSMCC2	SSMCD1	SSMCD2
225	265.99	314.14	33.99	46.17
226	362.47	589.13	30.22	41.92
227	352.56	533.61	41.44	54.35
228	271.04	339.00	26.02	37.66
229	236.01	282.82	13.22	24.51
230	266.06	362.60	19.34	30.26
231	324.80	462.89	34.46	47.20
232	305.55	395.40	33.25	45.46
233	361.71	413.13	136.32	149.63
234	289.64	336.02	41.34	53.13
235	293.88	363.68	32.76	44.15
236	410.86	606.95	34.31	45.66
237	376.27	568.77	32.69	49.03

NOTE: SSMCD3 = 35.03; SSMCD4 = 46.78

($440.73) reported in Table 7. While this seems diametrically opposed to the common belief that the cost of a full bed is not substantially greater than that of an empty bed (because of the high fixed-cost component), it is consistent with the findings of Evans and Walker (1972) and a number of other hospital cost analyses reviewed by Lipscomb et al. (1978). What is in marked contrast to Evans and Walker's results, however, is our MC/AC ratio resulting from shifts in lengths of stay with admission rate constant. The ratio of SSMCD3 to the weighted average of DAYEXD values reported in Table 7 is 0.781, whereas they found a marginal cost of 'between one-third and one-half of average cost' (416). Of course it is not difficult to estimate this ratio without the simulation program. Since DAYEXD = AC here and

$$\text{DAYEXD} = a_o + a_1 B/D + a_2 B^2/D + a_3\text{EDRAT} + a_4\text{WAGE} + \ldots ,$$

total inpatient cost, IPCOST, is just DAYEXD·D:

$$\text{IPCOST} = a_1 B + a_2 B^2 + D(a_o + a_3\text{EDRAT} + a_4\text{WAGE} + \ldots)$$

so that $\text{MC} = \text{AC} - a_1 B/D - a_2 B^2/D$.

Using the mean values for a_1 and a_2 from Table 12, the B and D values for our fictitious hospital, 500 beds and 146,000 days, and the mean DAYEX(AC) value from Table 7 ($44.85), this becomes

$$\text{MC} = \$44.85 - (2086.3)(500/146000) - (1.673)(500^2/146000) = \$34.84,$$

remarkably close to our SSMCD3 value of \$35.03.

The MC/AC ratio based on $\overline{\text{SSMCD1}}$/DAYEXD is identical to that for SSMCD3 at 0.781. These results do not necessarily refute the conventional wisdom, however. As Evans and Walker suggested, they may be reconciled with the 'high fixed costs' theory if hospitals draw on resource markets that are flexible enough to allow them to make rapid input adjustments in response to unexpected changes in days stay. Or, if hospitals are rarely called on to respond to unexpected changes in demand for their services, 'either because demand is stable from period to period, or because admissions and lengths of stay are adjusted to meet forecast' (Evans and Walker 1972, 416), marginal and average costs will appear to be closely related. A behavioural analysis of hospitals of which the majority reach their total day (and thus occupancy and case flow) forecasts, is unlikely to provide a low MC/AC ratio even if, in fact, the marginal cost of handling *unexpected* inpatient days is low in relation to the average cost. If the hospitals that form the observations in our data set are able to stick to their forecasts, and if their budgets are based on the forecast of inpatient days (which automatically becomes cost reimbursement on a per diem basis if the forecasts are correct), then it is inevitable that marginal and average costs will bear a striking resemblance to each other.

Closing beds in order to maintain a constant occupancy rate increases marginal per-case costs by from 10 to 80 per cent and the marginal per diems by from 12 to 135 per cent. As will be seen in the following chapter, these differences are of critical importance when we are trying to measure the costs and benefits of community health centres. If the decision about their future were to depend entirely on the possibility of reducing hospital costs, the absence of a commitment to close beds freed by lower hospital utilization rates for patients of those centres would leave a very weak case for the continued and expanded existence of CHCs.

The diagnosis-specific marginal costs per case without bed adjustment range from \$229.73 for our diagnostic category 219 to \$599.84 for category 185 (see Table D.2 for diagnostic descriptions of each category). The range for the marginal costs with bed adjustment is \$265.81 (category 110) to \$1062.55 (with category 185 repeating). It turns out, gratifyingly, that the low-cost categories such as 110, 118, 219, and 229 are indeed the categories we might have expected to yield low costs: 110 – hypertrophy of tonsils and adenoids; 118 – diseases of teeth and supporting structures; 219 – generally uncomplicated external head and neck wounds; 229 – toxic effect of chiefly non-medical substances. In general these categories have low $\bar{H}_j$ (case complexity) values or short lengths of

stay or both. For example, while there are numerous diagnostic categories with case complexity values lower than code 110, the average length of stay for all 'hypertrophy of tonsils and adenoids' separations from Ontario hospitals in 1974 was 1.9 days (Ontario n.d. 1976c). Category 219 has an extremely low average $\bar{H}_j$ of 0.559 and a length of stay (for 1974) for 3.8 days, which is far below average.

At the opposite extreme, the highest marginal separation cost is for 'spina bifida and congenital hydrocephalus,' both very serious anomalies. For those conditions, we find a high case complexity (3.17) and a 1974 average length of stay in Ontario of 26.9 days. Other diagnostic categories that clustered near the high-cost end of the range include a number of the malignant neoplasms (categories 017-037), in particular those of the brain (code 035; $\bar{H}_j = 2.197$; ALS = 24.9 days in 1974); schizophrenia ($\bar{H}_j$ not extraordinarily high at 1.856, but a length of stay of 26.5 days more than makes up for it); category 186 – neurofibromatosis (developmental changes in the nervous system, muscles, etc.) and other congenital anomalies of nervous system –with $\bar{H}_j$ of 2.8 and ALS of 18.7 days; category 190 – patent ductus arteriosis (abnormal open cavity within the arterial duct) and other anomalies of the aorta (main artery from the heart) – which has an H_j of 4.165 (the highest value of the 237 categories) and a 1974 ALS of 13.6 days; and category 213 – fracture of the femur, not a particularly complex diagnostic category but one that requires extended recuperative time in hospital (ALS of 32.6 days in 1974). In short, the relative marginal costs seem, at least in theor ordinal ranking, to be reasonable.

One surprise was the relatively low marginal per case cost of category 141 – nephritis and nephrosis. In a similar analysis of British Columbia hospitals over an earlier period (1966–73) by Barer (1977), this category had the highest per case marginal costs, and it is generally considered to consist of serious illnesses. Indeed, its mean case complexity ($\bar{H}_j$) was very high – 3.378, The clue for this category lies in a comparison of marginal cost per day and per case figures. Its marginal inpatient per diem is the highest among the 237 diagnostic classes at $252.28 (with no bed adjustment). In fact it exceeds the second ranked category by over $100. The explanation apparently lies in recent changes in the treatment of this disease. It now responds readily to short-term intensive therapy, so brief in fact that the ALS for this condition in Ontario in 1974 was 2.7 days. It has been suggested that this may be a result of the recent growth of in-hospital dialysis programs. Each time a patient receives dialysis another separation for this diagnosis is recorded; the treatment is extremely expensive, but the admissions seldom result in lengths of stay of more than two or three days. A reconciliation with the British Columbia results is suggested by the fact that in 1969 the average length of stay for Ontario of nephritis and nephrosis cases was 6.8 days, but by 1972 it had fallen to 3.3 days.

While 'nephritis and nephrosis' occupied the top of the marginal inpatient per diem ladder, other high-cost categories included 233 – plastic surgery – which was another category with a relatively high case complexity but short length of stay (3.4 days in 1974); 193 – cleft lip – with the second highest $\bar{H}_j$ of 3.830; 187 – congenital anomalies of the eye – with $\bar{H}_j$ of 2.706 but again a short ALS; and 78 – strabismus (deviation of visual axes of the eye which leaves the patient unable to focus) – with an $\bar{H}_j$ of 2.020 and an ALS of 2.3 days. At the low end of the scale is category 219, which is thus the lowest on both per case and per day bases. Other low per diem cost diagnoses are non-medical agent toxicity (229 again), various lacerations and contusions (223 and 224), fracture of upper limb (212), gastritis and duodenitis (125), and influenza (105). These categories all have low-complexities and lower than average lengths of stay.[6]

The marginal costs resulting from this simulation seem then to be significant improvements over even inpatient per case costs and per diems.[7] In particular, they provide a source of diagnosis-specific marginal costs that may be used for estimating hospital cost savings associated with community health centres where studies of those centres provide diagnosis-specific utilization data. We turn to that task in the next chapter.

6 Recall that the marginal costs reported in Table 13 are all expressed in 1969 dollars. An approximate conversion to 1974 dollars may be made by applying our Paasche index for the hospital sector reported in Table C.2. That series suggests that marginal costs in 1974 dollars would have been approximately 63 per cent higher than the 1969 figures of Table 13. Thus the range for SSMCC1 would become \$374.23 to \$977.14 and for SSMCC2, \$433.00 to \$1730.89. The per diem ranges would be SSMCD1 – \$12.82 to \$410.96, and SSMCD2 – \$30.19 to \$434.23.

7 A few other studies have attempted to derive diagnosis-specific cost information (Thompson et al. 1975; Lave and Leinhardt, 1976; and Fetter et al. 1980) using American hospitals.

6

Hospital cost implications of CHC and PGP experiences

The preceding three chapters of this study described the estimation of per case and per day inpatient marginal costs for 237 diagnoses. This chapter attempts to link those estimates with the utilization statistics from two Canadian studies of community health centres and two American studies of prepaid group practices reviewed in Chapter 2. These four studies (Hastings et al. 1973, McPhee 1973, Densen et al. 1960, and Riedel et al. 1975) reported hospital utilization differentials disaggregated to varying degrees by diagnosis. Linking the differentials with the marginal costs provides a range of estimates of the potential reductions in hospital expenditures realizable by these alternative delivery modes for primary medical care.

In Canada the only previous attempts (to my knowledge) to translate utilization differentials into their dollar equivalents were by McPhee (1973) and Barer (1977). This chapter extends and refines the latter. McPhee estimated hospital cost savings and overall clinic cost effectiveness. For hospitals his estimates were based on the assumption that 'the potential hospital cost saving is 70 per cent of the average cost per separation times the reduction in separations, plus 20 per cent of the average daily cost of hospital care times the number of days reduced length of stay' (25). This worked out to a 15 per cent total saving in hospital costs 'per beneficiary receiving physician services' (28). Since 20 per cent of potential beneficiaries did not contact a physician during the study period, and given the average inpatient cost of \$110 in Saskatchewan during 1972-3, 'the per capital hospital cost for those who did receive physician services during the year' (ibid.) was \$137.50. The 15 per cent saving then was approximately \$20.50 per patient with one or more physician contacts (110/0.8 times 0.15). Using this relatively crude estimate as a base, McPhee found total hospital cost savings from the three Saskatchewan clinics to be close to \$700,000. However, he also found that

the actual payments made to each of the clinics for ambulatory care, administration, and so on exceeded the sum of estimated approved fee schedule payments for physician services, 'saved' inpatient hospital costs, and 'saved' outpatient hospital costs. The overall cost effectiveness of the clinics was therefore left in doubt.

The limited number of American studies that have attempted to estimate the cost differences associated with alternative delivery organizations have tended to focus on total expenditures. Five such studies are reviewed by Luft (1978a). Their method consists of aggregating premiums and out-of-pocket costs to estimate total cost of care. Of course the accuracy of this method depends directly on how well these two figures represent total costs. Information on out-of-pocket costs is generally available through patient surveys with their attendant problems of memory and accuracy.[1] Premiums paid to a PGP will be a good proxy for total costs when combined with out-of-pocket costs only if the sum of the premiums plus out-of-pocket costs is exactly equal to the total costs incurred by the group in the provision of care to its members. If the group makes abnormal profits, such a measure will overestimate costs for purposes of comparison with non-group consumers. And if in any period being studied the group is forced to deficit-finance, this total cost proxy will underrepresent costs. Similarly, premiums paid to a third party by members of a control group will undoubtedly include a component to cover the administrative costs and normal profit of that third party. This method provides information on the relative costs to the consumer of delivery alternatives. For Canadian public policy, however, it is deficient on a number of counts, not the least of which is the absence of any significant out-of-pocket costs or inter-plan premium variation in Canada. Nevertheless, all five studies cited by Luft showed total costs to be lower for PGP members than for the comparative populations (ibid., 1337).

The method just described does not generally permit the isolated estimation of potential hospital cost savings. In the final analysis hospital cost differences are undoubtedly less important than the overall cost differences. But in Canada, where physician billing data may be used for ambulatory cost estimation but no comparable hospital billing data exist, the method used here facilitates such 'overall analyses'. A recent American study that did disaggregate the components (Perkoff et al., 1976) had access to hospital billing data. As noted earlier, Perkoff et al. reported significantly fewer hospital days for PGP enrollees than for their control group counterparts. The billing data showed that the average inpatient per diem cost was 24 per cent higher for the PGP members than that for

1 Hetherington et al. (1975) provide a more extensive discussion of problems in using out-of-pocket cost measures. For more recent discussions of the cost implications of PGPs see Luft (1980a, 1980b).

the controls. This had the effect of reducing the 30 per cent utilization differential favouring the PGP to approximately 5 per cent (with ordinal ranking unchanged) when translated into cost terms. Perkoff et al. also reported that the PGP members 'had higher utilization rates for office visits and consultations, diagnostic x-ray and laboratory services, and preventive services' (ibid., 439), although there was some doubt about the comparability of the preventive services data for the two groups. This higher ambulatory service utilization outweighed the reduced inpatient care, so that unlike the five studies reviewed by Luft (1978a), Perkoff's study found the control group's estimated incurred costs to be lower than those of the PGP members. Perkoff et al. note that even if the per diems had been equal for the two groups, the overall PGP costs per enrollee would still have exceeded those for members of the control group. (The cost of premiums was not included in the analysis.)

The Ontario hospital reimbursement process does not generate meaningful hospital billing data. But even if it did, the information might still be inadequate for us here. If a hospital relies on billings to cover its costs, the charges to each patient will have to incorporate a prorated share of fixed costs. In other words billings would then be based on average rather than marginal costs. Yet an investigation into the hospital-cost-saving potential of CHCs or PGPs is surely concerned in the short run with 'saved' marginal costs. If a CHC is able to reduce inpatient throughput in a hospital but that hospital's costs are largely fixed, the saving from a social viewpoint will be better represented by the marginal cost estimates. Of course the costs generated in the previous chapter also allow us to investigate the impact of reduced utilization in the longer run if the utilization differentials are generalized to larger populations and the bed capacity is adjusted accordingly.

This chapter tries to estimate the potential hospital cost saving implicit in generalizing the experiences of the populations in the four PGP/CHCs reviewed in Chapter 2 (which reported diagnosis-specific data). In effect we transplant each 'PGP or CHC versus control' study into Ontario and assume that the utilization patterns for each group would have been similar if the populations had been composed of Ontario residents. Those patterns are then generalized to the entire population of Ontario. The numbers resulting from the analysis provide a range of hospital-cost-saving estimates for a hypothetical situation in which each Ontario resident received primary care from a CHC or PGP.

THE CANADIAN EVIDENCE

Hastings et al. (1973, 94) report hospital utilization by GHA members (the CHC) and their control counterparts. Table 14 displays the discharge differentials calculated from that study. Although Table 14 represents discharges other than

TABLE 14

Comparative discharge experiences of dual choice populations: GHA vs Prudential

Diagnostic category	(1) Discharge rate* per 1000 GHA subscribers	(2) Ratio GHA/ Prudential	(3) Estimated discharge rate per 1000 Prudential Subscribers	(4) Discharge rate differential per 1000 subscribers (Prudential-GHA)
Neoplasms	5.8	0.88	6.6	0.8
Allergic, endocrine, metabolic	2.9	0.83	3.5	0.6
Mental	4.7	0.76	6.2	1.5
Nervous system	5.9	1.11	5.3	–0.6
Circulatory	7.9	1.18	6.7	–1.2
Respiratory	12.6	0.41	30.7	18.1
Digestive	14.5	0.90	16.1	1.6
Genito-urinary	11.1	0.75	14.8	3.7
Deliveries, complications	20.9	0.80	26.1	5.2
Musculoskeletal	3.5	0.64	5.5	2.0
Symptoms, etc.	3.4	2.43	1.4	–2.0
Accident, poisoning, violence	8.6	1.09	7.9	–0.7
Balance of cases	7.6	1.17	6.5	–1.1

* Other than newborns

SOURCE: Columns (1) and (2) are from Hastings et al. (1973, 94, Table 2). Column (3) = (1) / (2). Column (4) = (3) – (1).

newborns, our marginal costs are derived using all discharges and deaths; however, the induced error is small and the direction of bias predictable.[2]

The diagnosis-specific utilization statistics provided by Hastings are reported only at the level of thirteen broad ICDA categories. This forces us to aggregate

2 At an early stage in the analysis, a comparison of CASEX (cost per separation) figures was made in order to determine their sensitivity to the exclusion of newborns. The CASEX value for all hospitals was at least as small when newborns were included as when they were excluded. This is as we would expect. In general, however, the differences were minimal, and to the extent that our case cost figures are already the result of considerable aggregation it was decided that deletion of newborns was unnecessary. It is worth noting that such a deletion would prompt an upward movement in our case cost figures. Thus, the combining of our figures here with utilization figures that exclude newborns slightly underestimates the potential expenditure savings.

our 237 diagnoses into the same thirteen categories. Obviously, but unavoidably, such a massive aggregation entails a considerable loss of detail. But the small sample size upon which the Hastings study was based precludes use of a finer breakdown even if one had been reported. In particular, the small number of discharges in many of the diagnostic categories would have made any calculated utilization differentials suspect.

The six years' case mix for the 182 hospitals in our sample was used to establish weights for aggregating case costs.[3] Thus, for the first category in Hastings' disaggregation, neoplasms, our diagnostic codes 017 through 047 inclusive were aggregated to compute

$$\mathrm{MCC}_N = \sum_{j=17}^{47} (C_j / C_N) \cdot \mathrm{MCC}_j ,$$

where MCC_N denotes estimated marginal cost per case for all neoplasms[4], C_j is the number of code j separations in the 182 hospitals in 1969-74, $C_N = \sum_{j=17}^{47} C_j$, and the MCC_j are the respective marginal cost figures from Table 13.

A similar procedure was undertaken using the per diem marginal costs, since Hastings also reported utilization differentials on a 'days of care' basis. Table 15 is the total days equivalent of Table 14 and is again taken from the data provided by Hastings. For each of the thirteen broad classifications employed by Hastings, Table 16 shows the included category codes from our modified OBC classification and the four aggregated marginal cost measures computed as explained above. For the per diem marginal costs, the share of broad-category

3 The use of the 182-hospital case mix as a source of weights for deriving broad category case costs is clearly a second- (or third-) best solution. Ideally one would wish to use the mix of the Sault Ste Marie study populations. However, if that mix were available the problem of a small sample size would probably not exist, a finer diagnostic utilization breakdown would have been provided, and the aggregation exercise would not have been necessary. The method used here involves the implicit and perhaps unrealistic assumption that in the broad categories reported by Hastings the mix of cases was similar to the mix in these 182 hospitals, or at least would have been with a sufficiently large sample size. The point of applying the case costs to four different utilization studies in this chapter is to minimize the possibility of adopting unrepresentative conclusions based on a single study.

4 For ease of presentation, the MCC/MCD notation is often substituted henceforth for the SSMCC and SSMCD variables of Chapter 5. They are one and the same in this chapter and represent the final aggregated marginal costs.

TABLE 15

Comparative total days stay of dual choice population: GHA vs Prudential

Diagnostic category	(1) Days per 1000 GHA subscriber years	(2) Ratio: GHA/ Prudential	(3) Days per 1000 Prudential subscriber years	(4) Days stay differential per 1000 subscriber years (Prudential-GHA
Neoplasms	63.1	0.80	79.1	16.0
Allergic, endocrine, metabolic	36.1	0.62	58.3	22.2
Mental	71.8	0.53	135.9	64.1
Nervous system	50.0	0.99	50.5	0.5
Circulatory	98.3	0.74	133.3	35.0
Respiratory	79.3	0.51	154.5	75.2
Digestive	155.6	0.86	181.2	25.6
Genito-urinary	78.1	0.83	94.3	16.2
Deliveries, complications	130.7	0.85	153.8	23.1
Musculoskeletal	50.7	0.56	90.7	40.0
Symptoms, etc.	26.6	2.03	13.1	–13.5
Accident, poisoning, violence	68.1	1.09	62.3	– 5.8
Balance of cases	70.6	0.91	77.5	6.9

SOURCE: Columns (1), (2), and (4) from Hastings et al. (1973a, 94, Table 2). Column (3) = (1) plus (4).

total days falling within each of our codes was used as the weight in place of the corresponding share of separations. Thus,

$$\text{MCD}_N = \sum_{j=17}^{47} (D_j \,/\, D_N) \cdot \text{MCD}_j \,.$$

Combining each of these sets of aggregated marginal cost figures with either the discharges or days stay differential, as appropriate, yields diagnosis-specific estimates of gross hospital expenditure savings. These results are reported in Table 17.

Interestingly, Hastings et al. report tonsillectomy and adenoidectomy (T and A) rates for children aged 0-14 as 8.8 per 1000 and 26.7 per 1000 respectively for the GHA and Prudential subscribers. It is not unreasonable to suppose that the majority of the T and A cases reported in Ontario were for patients falling within that age range. Thus, our computed SSMCC1 cost of $243.31 for code 110 will be relatively representative of the cost of this case type for that age group. The

TABLE 16

Aggregation of 237 marginal costs into thirteen broad ICDA categories

Diagnostic category from Hastings et al. (1973)	237–Category Code Equivalents	SSMCC1	SSMCC2	SSMCD1	SSMCD2
Neoplasms	017 – 047	407.50	610.25	40.74	53.16
Allergic, endocrine, metabolic	048 – 055	355.03	543.41	32.09	44.06
Mental	059 – 067	384.97	605.49	35.91	47.81
Nervous system	068 – 084	359.49	490.62	46.31	59.30
Circulatory	085 – 103	375.44	580.25	31.79	43.59
Respiratory	104 – 117	274.02	345.77	27.58	38.75
Digestive	118 – 140	313.75	434.01	29.95	41.36
Genito-urinary	141 – 159	332.10	422.47	49.25	61.23
Deliveries, complications	160 – 171	301.44	369.81	36.63	48.21
Musculoskeletal	177 – 184	360.47	545.19	34.79	46.95
Symptoms, etc.	206, 207	292.55	365.86	36.26	48.48
Accidents, poisoning, violence	208 – 231	309.10	440.60	29.21	40.94
Balance of cases	001 – 016, 056 – 058, 172 – 176, 185 – 205, 232 – 237	310.43	403.00	36.66	48.54

NOTE: Balance of cases include infective and parasitic diseases, diseases of the blood and blood-forming organs, diseases of the skin and subcutaneous tissue, congenital anomalies, certain causes of perinatal morbidity and mortality, and special conditions and exams without sickness.

differential of 17.9 discharges translates, then, into an additional expenditure burden of $4355.25 per 1000 subscribers. Table 17 shows that the cost differential per 1000 subscribers for the entire respiratory category, in which T and As are but one entry, is $4959.76. Clearly, the major portion of that figure derives from vastly different admission experiences for this particular surgical procedure.

The SSMCC1 figures in Table 17 show that the expenditure differential between subscribers to the two plans is about $8.30 per subscriber. When the per diem utilization differential is used this figure becomes $10.30. The difference undoubtedly derives from the fact that lengths of stay for populations in this study were unlike those of the Ontario population on which our MCC1 and MCD1 estimates were based. GHA members incurred 25 per cent longer stays (on average) than their control counterparts for respiratory conditions, so that the importance of that category in the estimated total cost differential was not nearly as marked when days stay data were the utilization base. These figures

TABLE 17

Diagnosis-specific cost differentials for Hastings study

Diagnostic category	(1) Discharge rate differential	(2) Cost differential based on SSMCC1	(3) Cost differential based on SSMCC2	(4) Days stay differential	(5) Cost differential based on SSMCD1	(6) Cost differential based on SSMCD2
Neoplasms	0.8	326.00	488.20	16.0	651.84	850.56
Allergic, endocrine, metabolic	0.6	213.02	326.05	22.2	712.40	978.13
Mental	1.5	577.46	908.24	64.1	2,301.83	3,064.62
Nervous system	–0.6	–215.69	–294.37	0.5	23.16	29.65
Circulatory	–1.2	–450.53	–696.30	35.0	1,112.65	1,525.65
Respiratory	18.1	4,959.76	6,258.44	75.2	2,074.02	2,914.00
Digestive	1.6	502.00	694.42	25.6	766.72	1,058.82
Genito-urinary	3.7	1,228.77	1,563.14	16.2	797.85	991.93
Deliveries, complications	5.2	1,567.49	1,923.01	23.1	846.15	1,113.65
Musculoskeletal	2.0	720.94	1,090.38	40.0	1,391.60	1,878.00
Symptoms	–2.0	–585.10	–731.72	–13.5	–489.51	–654.48
Accidents, poisoning, violence	–0.7	–216.37	–308.42	–5.8	–169.42	–237.45
Balance of cases	–1.1	–341.47	–443.30	6.9	252.95	334.93
Totals	—	8,286.28	10,777.77	—	10,272.24	13,848.01

SOURCE: Column (1) from Table 14; columns (2), (3) = (1) × respective columns from Table 16; column (4) from Table 15; columns (5), (6) = (4) × respective columns from Table 16.

suggest that the approximately 3350 Algoma Steel Corporation workers who chose the GHA plan 'saved' around $30,000 in inpatient hospital costs.[5] Projections of this experience and discussion of the impact of bed closures is left until the data and results are presented for the other four studies.

In Chapter 2 it was noted that McPhee (1973) did not provide a diagnosis-specific disaggregation of the hospital utilization experiences of subscribers and non-subscribers to the clinics. With the aid of the Saskatchewan Department of Health[6] the data on separations were acquired in a disaggregated form. The utilization data for that study had been compiled according to the 188-category Canadian Morbidity List (taken from the Ontario Hospital Service Commission's *Annual Report for 1969*). Exact equivalents between the Canadian list and our own could not always be established. For example, code 5 in the 188-category list is composed of ICDA categories 040-043. Our category 009 contains ICDAs 045 and 046 in addition to 040-043, but since 009 was clearly the closest equivalent it was adopted. Things were not always that straightforward. Code 8 in the 188-category list contains ICDA codes 044-061, 067-068, and 071-079. Codes 067-068, 060-061, and 071-079 are in our classification 012. But the ICDA range 044-061 includes 045 and 046, which were already included in code 5 because of their being in our category 009. In this and similar cases we resorted to the 1974 edition of the Ontario Ministry of Health's *Hospital Statistics* for approximate weights. Our category 009, as noted above, is composed of ICDA-8 codes 040-043, for which there were a total of twenty-five separations in Ontario in 1974 and 045-046, for which there were 310 separations. Therefore, 0.9 (approximately equal to 310/335) was the weight assigned to our category 009 in code 8 in the 188-category list.

One more example will further clarify the method. Code 16 in the 188-category list comprised malignancies of the trachea, bronchus, and lung. Malignancies of the trachea are part of our code 023, while the others make up our entire code 022. Again, we refer to the 1974 Ontario *Hospital Statistics* which reports only twenty-one cases of 'malignant neoplasm of trachea' along with 939 other separations falling within code 023. The weight on our code 023 in code 16 in the 188-category list would therefore have been approximately 0.02. Accordingly, our 023 was left out of code 16 in the 188-category list. The equivalences established between the 188-category list and our modified OBC codes may be found in Appendix F.

5 Hastings et al. (1973) reported that approximately 62 per cent of the 5400 eligible employees enrolled in the GHA plan.

6 I am indebted to N.D. Adams, then Assistant Deputy Minister of Health, Saskatchewan, and to Linda Cant of the Research and Planning Branch, Saskatchewan Department of Health, for their assistance in obtaining these data.

The type of overlap described above did not happen often, and the incidence is shown by the weights contained in parentheses in the 237-category column of Appendix F.

Although the McPhee study was conducted during 1972-3, the 182-hospital case mix for the six years 1969-74 was again used as a source of weights for deriving marginal costs for each of the 188 Canadian Morbidity List categories. Comparable weighting schemes across the four studies seemed more important than matching, say, Ontario's case mix in 1972 with the Saskatchewan clinics' 1972-3 experience. Thus, the MCC1 value for code 8 in the 188-category list was derived as

$$\text{MCC1}_8 = (\text{MCC1}_{008}\cdot C_{008} + \text{MCC1}_{010}\cdot C_{010} + \text{MCC1}_{012}\cdot C_{012} + \text{MCC1}_{009}\cdot \hat{C}_{009}) \,/\, (C_{008} + C_{010} + C_{012} + C_{009}),$$

where $\hat{C}_{009} = (0.9)\cdot C_{009}$, and each of C_{008}, C_{009}, etc. refer to total separations from our 182 hospitals over the six years with recorded principal diagnoses falling within our 237-category codes 008, 009, etc. respectively. Appendix F reports the resulting marginal case costs for the 188 categories. MCD1 and MCD2 were not computed because disaggregated days-stay information was not available. The disaggregated separations data for each of the three Saskatchewan CHACs and their controls were converted to rates per 1000 subscribers using the following estimates of subscriber populations:[7]

– Regina: McPhee (1973), Table 1, reports 156 separations per 1000 CHA clinic patients. The data provided by the Department of Health show a total of 528 separations. Thus the population estimate is (528/186)1000 = 2839. Similarly, the non-CHA population is estimated to be 46,335.
– Saskatoon: CHA: (669/178)1000 = 3758; Non-CHA: (10,093/229)1000 = 44,074.
– Prince Albert: CHA: (609/228)1000 = 2671; Non-CHA: (2629/304) = 8648.

Again, small sample problems were evident on occasion. Taking Regina as an example, the disaggregated CHA data showed a total of 528 separations, which, spread over 188 categories, is fewer than three separations per category. While

7 'Population' refers here to patients receiving at least two physician services during the study period. The problems with employing such 'user populations' for this type of analysis were considered in Chapter 2.

the control group reported 10,569 separations, an average of 56 per category, fifty-four of the 188 categories had positive non-CHA –CHA differentials because there were no separations within the CHA sample. Nevertheless, it seemed useful to compare these data with those from the Sault Ste Marie clinic, where the opposite extreme – a massive case-cost aggregation – was necessary.[8]

The resulting separations differences per 1000 subscribers were combined with the marginal costs calculated in the manner described earlier (and reported in Appendix F) to provide cost saving estimates. The total cost differentials based on MCC1 range from $13.20 (Regina) to $22.90 (Prince Albert) per subscriber. While McPhee did not provide diagnostically disaggregated days stay data as Hastings did, aggregate age-sex adjusted differentials were reported as follows:

	Regina	Saskatoon	Prince Albert
CHA	1619	1373	2137
Non-CHA	2154	1956	2837
Differential	535	583	700

If we apply our MCD3 value of $35.03 to each of these differences, the result is a somewhat higher cost differential range of $18.74 to $24.52 per subscriber.

At first glance these figures appear markedly higher than the comparable figures of $8.30 (based on MCC1) and $10.30 (based on MCD1) from Sault Ste Marie. However, McPhee considered 'only patients receiving more than one physician service during the 12-month study period' (1973, 6). Thus the population figures derived above, upon which the hospital utilization experience per 1000 beneficiaries is based, refer only to persons satisfying this requirement. In contrast, the utilization figures in the Hastings (1973a) study are based upon a pre-defined population of known size.

To compare the two studies we must 'extrapolate' from the physician contact data contained in each. McPhee reported that approximately 15 per cent of persons visiting a physician during the study period were attended by a physician

8 The McPhee data are therefore useful only for comparative purposes. They are included here for that reason and because the degree of diagnostic disaggregation allows a further illustration of the method. However, the utilization differentials are based on user populations rather than subscriber populations, and on extremely small samples in each diagnostic category. In short, if this were the only study to which the marginal costs were being matched, it would be of little use. Such is the general state of this sort of utilization data.

only once.[9] Our population figures may reasonably be considered, then, as representing 85 per cent of the total number of persons receiving physician care. If we multiply all our separations per 1000 'subscribers' by 0.85 (or equivalently multiply the separation differentials by 0.85) and recompute the cost differentials, we arrive at the following total cost differentials per 1000 'subscribers:'[10] Regina: (\$13,203)·(0.85) = \$11,223; Saskatoon: (\$16,841)·(0.85) = \$14,315; and Prince Albert: (\$22,880)·(0.85) = \$19,448.

Derivation of a comparable figure for the Sault Ste Marie clinic requires information on the percentage of the population studied that received any physician services. From the Hastings et al. (1973) data we are able to assemble the following information:

	Population	Percentage receiving some physician services	Estimated population receiving at least some physician services
GHA	3348	68.9	2307
Prudential	2052	65.2	1338
Total			3645

Since the neoplasm discharge rate of 5.8 per 1000 reported in Table 14 was based on a population of 3348, it follows that the discharge rate per 1000 subscribers receiving some care would be $5.8/0.689 = 8.41$. Similarly, whereas Prudential beneficiaries recorded 6.59 discharges per 1000, this becomes 10.11 discharges

9 Unfortunately, unlike the Hastings et al. (1973) study, the McPhee paper did not report separate figures for each subscriber population, so that 15 per cent was used for both.

10 The necessary and implicit assumption, of course, is that those receiving only one physician service during the twelve-month study period incurred no hospital care. Although this may be an overstatement, it is probably not too unrealistic, because referrals and second visits seem to be the rule, rather than the exception, before admission to hospital. An obvious exception would be emergency cases. In any event, a large proportion of emergency cases are likely to require followup visits to a physician after discharge from hospital. Except where such visits fell outside the study period, these patients would be recorded as part of the population receiving at least two physician contacts. Furthermore, to the extent that the resulting admission rates per 1000 beneficiaries underestimate the actual experience of the populations receiving some physician care, an assumption of 'non-discrimination' between populations (i.e. same hospitalization experience of one-time physician users for both population groups) would allow us to proceed as we have done without loss of accuracy. If the hospitalization pattern reported by McPhee did extend to one-service beneficiaries (implying that our utilization differentials are downward-biased), the present estimates would understate the magnitude of the expenditure differentials a little.

using the new population base. The result is that the discharge rate differential of 0.8 (Table 17) is now (10.11 − 8.41) = 1.7. The entire procedure, and a corresponding reworking of Table 17 is contained in Table 18. The resulting cost differential estimate of $15,000 is comparable to the Saskatchewan estimates.

In summary, then, the hospital utilization experiences of four matched populations suggest potential hospital expenditure differentials ranging from approximately $11.20 to slightly more than $19.40 for each subscriber receiving some medical care in the time periods being studied and assuming no bed stock adjustment.[11] In all cases, beneficiaries of the CHCs were on the low-cost end of the differences.

Before leaving the Canadian evidence to look at American experience with PGPs, the implications of applying the marginal cost estimates to the Hastings data are considered briefly. The most direct means of obtaining rough estimates of expenditure differences is to apply gross per separation and per diem figures to the aggregate utilization differences. From Table 7 we obtain per diem and inpatient per diem figures of $52.61 and $41.77 respectively for 1969. A simple calculation yields a per separation cost of $557.25, and the CASEXD inpatient cost per separation value for 1969 was $442.42 (all figures based on our 182-hospital sample). The aggregate separations and days stay differentials reported by Hastings were 27.4 and 309.2 per 1000 members respectively. These yield the figures in Table 19. Since inpatient costs were estimated to be about 80 per cent of total operating costs, and since we note in Chapter 5 that the ratios of inpatient marginal cost to average cost were 0.74 and 0.78 respectively for MCC1 and MCD1, we would anticipate the ratio of Row 5 to Row 3 in Table 19 to be about 0.59 for separations and 0.62 for days stay. The expected Row 5 figures would then be about $9000 and $10,000. In fact, the separations-based cost differential is even lower than the former figure, which suggests that the marginal per case costs of the diagnoses in which the CHC displayed the greatest utilization differentials were lower than the average MCC1 value of $325.00. Table 16 confirms this suspicion. The bulk of the separations-based cost differential derived from the 'Respiratory' category, for which our estimated MCC1 value was $274.

What should be clear from Table 19 is that attempting to estimate hospital cost savings by applying readily available per diems will result in upward-biased estimates of those savings. For days stay, the Row 3 figure exceeds that in Row 5 by around 60 per cent, and the overestimate is even greater, over 80 per cent

11 Of course these figures are expressed in 1969 dollars. Applying our hospital cost index (Table C.2) gives a 1974 range of $18.30 to $31.60, and even if we assume an increase in the hospital cost index no greater than that for the Canadian CPI during the period 1974-8, the equivalent 1978 range would be around $25 to $44 a person a year.

TABLE 18

Hospital utilization by GHA members and Prudential beneficiaries (other than newborns) who were attended to by a physician at least once, with cost implications

	Discharge rate per 1000 persons						
Diagnostic category	GHA	Prudential	Differential GHA–Prudential	Estimated MCC1	Estimated MCC2	Estimated cost differential based on MCC1	Estimated cost differential based on MCC2
Neoplasms	8.4	10.0	1.7	407.50	610.25	692.75	1,037.43
Allergic, endocrine, metabolic	4.2	5.4	1.2	355.03	543.41	426.04	652.09
Mental	6.8	9.5	2.7	384.97	605.49	1,039.42	1,634.82
Nervous system	8.6	8.2	–0.4	359.49	490.62	–143.80	–196.25
Circulatory	11.5	10.3	–1.2	375.44	580.25	–450.53	–696.30
Respiratory	18.3	47.1	28.8	274.02	345.77	7,891.78	9,958.18
Digestive	21.0	24.7	3.7	313.75	434.01	1,160.88	1,605.84
Genito-urinary	16.1	22.7	6.6	332.10	422.47	2,191.86	2,788.30
Deliveries, complications	30.3	40.1	9.8	301.44	369.81	2,954.11	3,624.14
Musculoskeletal	5.1	8.4	3.3	360.47	545.19	1,189.55	1,799.13
Symptoms, etc.	4.9	2.1	–2.8	292.55	365.86	–819.14	–1,024.41
Accidents, poisoning, violence	12.5	12.1	–0.4	309.10	440.60	–123.64	–176.24
Balance of cases	11.0	10.0	–1.0	310.43	403.00	–310.43	–403.00
Total						15,698.85	20,603.73

SOURCE: Discharge rates – see text
Marginal cost estimates – Table 16

TABLE 19

Expenditure differentials based on alternative cost measures from Hastings et al. (1973)

	Separations	Days stay
Utilization differential	$ 27.4	$ 309.2
(1) Total operating cost per separation or days stay (182 Ontario hospitals, 1969)	557.25	52.61
(2) In-patient cost per separation or days stay (182 Ontario hospitals, 1969)	442.42	41.77
(3) Estimated cost differential based on (1)	15,268.7	16,267.0
(4) Estimated cost differential based on (2)	12,122.3	12,915.3
(5) Diagnosis-specific marginal cost based expenditure differential estimate	8,286.3	10,272.2

NOTE: For Row 5 see Table 17.

when the separations data are used. Even applying the inpatient average cost estimates will yield upward-biased figures.

In addition, estimates based on diagnostically differentiated inpatient marginal costs may be significantly different from estimates based on a single inpatient marginal cost figure (such as MCD3). The difference in the separations-based estimates of about 8 per cent ($9000 vs $8286) is quite remarkable in view of the very aggregated nature of the diagnostic categories in the Sault Ste Marie study.

EVIDENCE FROM THE UNITED STATES

In Chapter 2, two American PGP studies were identified as reporting diagnostically disaggregated utilization experiences. The figures in Table 20 are taken directly from Densen et al. (1960). These figures are based on well defined populations of 25,011 GHI subscribers and 17,716 HIP subscribers, and are thus not (as in the case of McPhee's figures) rates per 1000 persons receiving care. Unfortunately, no data are provided for the physician-visit experience of the two populations so that comparisons must be limited to the original Sault Ste Marie data of Table 17.

A cursory examination of Table 20 suggests immediately that our analysis will be facilitated by separate consideration of male and female admissions. Less

TABLE 20

Annual hospital admission rates by diagnosis, adjusted for age and union local within each sex, 1 July 1956–30 June 1957 (per 1000 population)

Diagnostic category		Men		Women	
		HIP	GHI	HIP	GHI
I	Infective and Parasitic Diseases	—	—	0.31	0.17
II	Neoplasms	12.90	10.21	18.47	23.39
	1 Malignant	5.58	5.59	4.08	4.11
	2 Benign and unspecified	7.29	4.62	14.39	19.28
III	Allergic, endocrine, metabolic, and nutritional	1.18	1.75	2.49	3.34
	1 Allergic disorders	—	—	0.33	0.66
	2 Diseases of thyroid	—	—	1.55	2.23
IV	Diseases of blood and blood-forming organs	—	—	0.16	0.43
V	Diseases of nervous system and sense organs	3.02	1.47	4.35	4.60
	1 Vascular lesions affecting C.N.S.	—	—	1.14	0.42
	2 Diseases of nerves and peripheral ganglia	—	—	0.20	0.66
	3 Diseases of the eye	—	—	2.32	2.68
	4 Diseases of the ear and mastoid process	—	—	0.51	0.61
VI	Diseases of circulatory system	13.98	18.55	6.78	9.46
	1 Rheumatic fever and rheumatic heart diseases	—	—	0.33	0.57
	2 Arteriosclerotic and degenerative heart diseases	8.87	13.16	1.91	2.77
	3 Other diseases of the heart	1.59	0.41	0.32	0.68
	4 Hypertensive disease	—	—	0.37	0.51
	5 Varicose veins	—	—	0.31	0.75
	6 Hemorrhoids	0.35	3.19	2.21	3.10
	7 Other diseases of circulatory system	1.14	1.37	1.35	1.09
VII	Diseases of respiratory system	3.21	8.93	2.57	5.73
	1 Acute upper respiratory infection	—	—	0.33	0.44
	2 Influenza, pneumonia, bronchitis	1.71	2.47	1.18	2.34
	3 Tonsillectomy and adenoidectomy	—	—	0.48	1.04
	4 Other diseases of respiratory system	1.50	5.13	0.59	1.91

TABLE 20 continued

Diagnostic category	Men HIP	Men GHI	Women HIP	Women GHI
VIII Diseases of digestive system	15.86	22.68	12.52	15.46
1 Ulcer of stomach or duodenum	4.20	4.77	0.48	1.30
2 Other diseases of stomach and duodenum	—	—	0.39	0.25
3 Appendicitis	—	—	1.69	1.54
4 Hernia	4.70	6.80	1.41	1.08
5 Other diseases of intestines and peritoneum	2.30	4.57	3.28	4.02
6 Diseases of the gall bladder	3.39	3.71	4.82	6.56
7 Diseases of the liver and pancreas	—	—	0.30	0.43
IX Diseases of genito-urinary system	12.66	9.34	9.82	13.13
1 Infections of kidney	4.64	4.79	2.12	2.89
2 Diseases of prostate	6.93	3.31	NC	NC
3 Diseases of breast	—	—	0.82	1.34
4 Diseases of ovary, tube, parametrium	NC	NC	0.42	0.52
5 Diseases of uterus and other female genital organs	NC	NC	5.39	8.30
X Diseases of skin and cellular tissue	2.19	2.03	1.74	1.80
XI Diseases of bones and organs of movement	4.05	2.43	2.07	2.91
1 Arthritis and rheumatism	—	—	0.27	0.69
2 Osteomyelitis; other diseases of bones and joints	3.88	1.37	0.48	0.52
3 Other diseases of musculo-skeletal system	—	—	1.32	1.69
XII Symptomatic complaints	4.74	1.34	0.96	2.15
XIII Accidental injuries	2.54	1.61	6.23	6.48

NOTE: NC signifies no cases. Rates are not shown when admissions total fewer than ten in both groups.

SOURCE: Densen et al. (1960, 1719). The reported GHI neoplasm components for females sum to 22.96, versus a stated total of 23.39. The malignant/benign breakdown was therefore adjusted from 4.03/18.93 (reported by Densen) to 4.11/19.28. In some cases the components did not sum to the broad total because all the components of the category were not included. In such cases, they have been added in an 'Other' category in Table 21.

than ten male admissions were reported for many categories. The other fact that Table 20 makes clear is that, as with the Hastings data, some massive aggregation is required in order to convert our 237-element marginal cost vectors into marginal costs corresponding to the less than fifty categories listed.

Tables 21 and 22 are, in a sense, our 'working sheets' for that study. Column 1 in each provides the admission rate differentials computed from Table 20. The second column indicates the nature of the aggregations undertaken. For each diagnostic category a best guess was made as to the most closely corresponding of our 237 categories. Once these ranges were established, weighted marginal costs were derived for each of Densen's categories in a manner identical to that described for the two earlier studies, using the six years' Ontario case mix as weights. The resulting MCC1-based cost differential for female admissions was $6614. This figure is considerably less than the $8286 derived from the Sault Ste Marie study, and it becomes even lower when combined with the male population experience. Because of the number of diagnostic subcategories for which male admission rates were not reported, the MCC1 and MCC2 values derived for Table 21 were not always applicable to Table 22, and additional aggregations were necessary, as indicated in the '237 Category Code Equivalents' column of that table. The cost differential for male subscribers (based on MCC1) was less than $2 per person! If there had been no sex-based dichotomy in the reported utilization data, we would have probably derived an overall cost differential of about $5660 per 1000 population, since the combined sample population was 80 per cent female and 20 per cent male. However, to consider the implications of this particular experience for a general population, an average of the two figures, $4225, would be more appropriate.

It is pointed out in Table 21 that the differentials do not include maternity and related cases. As maternity care was not covered by the union plans, the relevant data were not reported. Purely for the sake of comparison, let us assume for a moment that the female population of this study would have used hospitals for these diagnoses in a manner similar to the beneficiaries reported on by Hastings et al. (1973), where the cost differential was $1567.49 per 1000 population for those cases. This addition pushes the total based on the 80/20 split to $6912.30, while a 50/50 weighting yields $5008.66, the latter figure being a full 40 per cent lower than the Sault Ste Marie study total. In short, this study suggests a much smaller hospital expenditure impact from the PGP setting.

The second American study providing a detailed diagnostic hospital utilization record (Riedel et al. 1975) was of the Federal Employees Health Benefits Program (FEHBP); it compared the hospital utilization records of employees belonging to the Group Health Association CHC or insured through Blue Cross-

TABLE 21

Diagnostic category cost differentials between GHI and HIP subscribers: female

Diagnostic category		Admission rate differential per 1000 female population GHI—HIP	237 category code equivalents	Estimated MCC1 ($)	Estimated MCC2 ($)	Estimated cost differential based on MCC1 ($)	Estimated cost differential based on MCC2 ($)
I		–0.14	001-016	289.29	387.50	–40.50	–54.25
II	1	0.03	017-038	460.31	721.20	13.81	21.64
	2	4.89	039-047	319.48	425.33	1,562.26	2,079.86
III	1	0.33	*109, 113(0.1), 175(0.4)	293.21	401.94	96.76	132.64
	2	0.68	048-050	361.64	524.18	245.92	356.44
	Other†	–0.16	051-055	354.13	546.02	–56.66	–87.36
IV		0.27	056-058	311.39	444.62	84.08	120.05
V	1	–0.72	091-093	416.59	685.13	–299.94	–493.29
	2	0.46	075	332.76	484.72	153.07	222.97
	3	0.36	076-081	379.24	484.84	136.53	174.54
	4	0.10	082-084	305.47	372.04	30.55	37.20
	Other†	0.05	068-074	394.53	641.14	19.73	32.06
VI	1	0.24	085-086	459.31	745.64	110.23	178.95
	2	0.86	088-089	379.57	588.06	326.43	505.73
	3	0.36	090	352.15	540.79	126.77	194.68
	4	0.14	087	317.80	474.38	44.49	66.41
	5	0.44	100	321.62	434.54	141.51	191.20
	6	0.89	101	302.08	393.70	268.85	350.39
	7	–0.26	087, 094-096, 097-099, 102-103	385.45	609.71	–100.22	–158.52

TABLE 21 continued

Diagnostic category		Admission rate differential per 1000 female population GHI—HIP	237 category code equivalents	Estimated MCC1 ($)	Estimated MCC2 ($)	Estimated cost differential based on MCC1 ($)	Estimated cost differential based on MCC2 ($)
VII	1	0.11	104	259.09	322.78	28.50	35.51
	2	1.16	105-107	291.31	411.43	337.92	477.26
	3	0.56	110	243.31	265.81	136.25	148.85
	4	1.32	*108, 111-112, 113(0.9), 114-117	339.56	456.75	448.22	602.91
VIII	1	0.82	121-122	354.11	531.34	290.37	435.70
	2	–0.14	123-126	281.27	385.39	–39.38	–53.95
	3	–0.15	127	280.09	360.29	–42.01	–54.04
	4	–0.33	128-129	299.66	397.86	–98.89	–131.29
	5	0.74	130-134	331.53	487.29	245.33	360.59
	6	1.74	137-139	339.75	484.96	591.17	843.83
	7	0.13	135, 136, 140	395.16	624.60	51.37	81.20
	Other†	0.13	118-120	258.44	296.52	33.60	38.55
IX	1	0.77	142	293.64	419.34	226.10	322.89
	2	—	*149, 151(0.33)	387.89	579.33	—	—
	3	0.52	152	269.96	322.19	140.38	167.54
	4	0.10	153	315.26	414.95	31.53	41.50
	5	2.91	154-159	292.52	365.87	851.23	1,064.68
	Other †	–0.99	*141, 143-148 150, 151(0.67)	371.31	457.82	–367.60	–453.24
X		0.06	*172-174, 176, 175(0.06)	298.68	416.69	17.92	25.00

TABLE 21 continued

Diagnostic category		Admission rate differential per 1000 female population GHI—HIP	237 category code equivalents	Estimated MCC1 ($)	Estimated MCC2 ($)	Estimated cost differential based on MCC1 ($)	Estimated cost differential based on MCC2 ($)
XI	1	0.42	177-179	400.04	664.57	168.02	279.12
	2	0.04	180-182	364.59	546.11	14.58	21.84
	3	0.37	183-184	309.35	415.63	114.46	153.78
XII		1.19	206-207	292.55	365.86	348.13	435.37
XIII		0.25	208-231	309.10	440.60	77.28	110.15
XIV	All remaining cases	0.46	059-067, 160-171, 185-205, 232-237	316.86	409.78	145.76	188.50
Totals						6,613.91	9,013.59

NOTE: maternity-care-related cases are not included.

* Where exact equivalents were not available, estimates were made of the importance of the relevant ICDA disease types in each of our 237 category codes. In III.1, for example, it was estimated that 40% of code 175 cases (other inflammatory conditions of skin and subcutaneous tissue) were allergy-related. These estimates were contrived in consultation with R.G. Evans and D.O. Anderson.

† Categories labelled 'other' are formed whenever the disaggregated figures do not sum to the broad category total in Table 20. The 'other' category contains the difference between the broad category total and the sum of the disaggregated categories. The category cost applied to 'other' categories is computed from the relevant 237 category codes as specified in the table.

TABLE 22

Diagnostic category cost differentials between GHI and HIP subscribers: male

Diagnostic category		Admission rate differential per 1000 male population GHI—HIP	237 category code equivalents	Estimated MCC1 ($)	Estimated MCC2 ($)	Estimated cost differential based on MCC1 ($)	Estimated cost differential based on MCC2 ($)
II	1	0.01	017-038	460.31	721.20	4.60	7.21
	2	-2.67	039-047	319.48	425.33	-853.01	-1,135.63
III		0.57	048-055, 109, 113(0.1), 175(0.4)	334.34	496.05	190.57	282.75
V		-1.55	068-084, 091-093	373.80	539.37	-579.39	-836.02
VI	2	4.29	088-089	379.57	588.06	1,628.36	2,522.78
	3	-1.18	090	325.15	540.79	-415.54	-638.13
	6	2.84	101	302.08	393.70	857.91	1,118.11
	7	0.23	087, 094-096, 097-099, 102-103	385.45	609.71	88.65	140.23
	Other	-1.61	085-086, 087, 100	344.41	504.19	-554.50	-811.75
VII	2	0.76	105-107	291.31	411.43	221.40	312.69
	4	3.63	108, 111-112, 114-117, 113(0.9)	339.56	456.75	1,232.60	1,658.00
	Other	1.33	104, 110	248.19	283.43	330.09	376.96
VII	1	0.57	121-122	354.11	531.34	201.84	302.86
	4	2.10	128-129	299.66	397.86	629.29	835.51
	5	2.27	130-134	331.53	487.29	752.57	1,106.15
	6	0.32	137-139	339.75	484.96	108.72	155.19
	Other	1.56	123-127, 135, 136, 140, 118-120	287.12	374.13	447.91	583.64

TABLE 22 continued

Diagnostic category		Admission rate differential per 1000 male population GHI—HIP	237 category code equivalents	Estimated MCC1 ($)	Estimated MCC2 ($)	Estimated cost differential based on MCC1 ($)	Estimated cost differential based on MCC2 ($)
IX	1	0.15	142	293.64	419.34	44.05	62.90
	2	–3.62	149, 151(0.33)	387.89	579.33	–1,404.16	–2,097.17
	Other	0.15	141, 143-148, 150, 151(0.67), 152-159	328.82	408.64	49.32	61.30
X		–0.16	172-174, 175(0.6), 176	298.68	416.69	–47.79	–66.67
XI	2	–2.51	180-182	364.59	546.11	–915.12	–1,370.74
	Other	0.89	177-179, 183-184	356.21	544.25	317.03	484.38
XII		–3.40	206-207	292.55	365.86	–994.67	–1,243.92
XIII		–0.93	208-231	309.10	440.60	–287.46	–409.76
XIV	All remaining cases	2.47	As in Table 21	316.86	409.78	782.64	1,012.16
Totals						1,835.91	2,413.03

Blue Shield. This study provided diagnostically disaggregated admissions and days stay data for forty-six categories. Differences in the benefits structure necessitated the elimination of 'diseases of oral cavity, salivary glands and jaw' from the breakdown before 237-code matching was attempted. The GHA age-sex adjusted admission rate for this category was 0.2 per 1000 member years, far below the corresponding BC–BS rate of 2.1. In addition the BC–BS average length of stay of 8.7 days was 50 per cent greater than that for GHA admissions. Neither result is surprising since inpatient hospitalization for the removal of impacted teeth was not a covered benefit under the GHA plan and benefits for oral surgery were limited to treatment of facial bone fractures and excision of tumours and cysts. In contrast, subscribers to the Blue Cross hospital insurance plan were entitled to collect benefits in full (for up to one year) for removal of impacted teeth (provided the teeth were extracted in a member hospital). Furthermore, the range of oral surgery procedures covered was far wider. One could argue that the complete exclusion of all cases within this category eliminates too much. However, estimating the portion of the differential (if any) that would have remained in the presence of equal benefit coverage would have been little more than guess work.

The first two columns of Tables 23 and 24 are taken directly from Riedel et al. (1975), and Column 3 contains the diagnosis-specific utilization differentials. The marginal cost aggregation done for this study used a somewhat different method from that used for the other studies described in this chapter. Appendix 2 of the FEHBP study contains the detailed ICDA classifications composing each of the authors' forty-six broader categories, just as our Table D.2 reports the ICDA-equivalent ranges for each of the 237 codes adopted here. Unfortunately, nately, exact matches were rare. The general method of aggregation can be described simply. Riedel's 'arthritis, rheumatism, and gout' category consists of ICDA codes 274 and 710-18. Our Table D.2 reveals that ICDA codes 710-18 correspond to our codes 177-9, but that ICDA 274 is part of a range of ICDA codes (274-9) that constitute our code 055. Since the six-year 237-code mix was to be used in this case too as a source of weights for aggregating the equivalent 237 category codes into the FEHBP categories, it would clearly be a misrepresentation to include our code 055 on the same basis as codes 177-9. What was required was information about the relative incidence of ICDA codes 274-9.

Using an ICDA-specific breakdown of separations for 1969, weights were assigned to some of our 237 category codes. In this example, it was found that gout (274) composed approximately 35 per cent of all cases with principal diagnoses 274-9. Accordingly, 35 per cent of our code 055 was included in the 237 category code equivalents for 'arthritis, rheumatism, and gout'. Thus, MCC 1 for

TABLE 23

Admission rates per 1000 member years and expenditure differentials: Blue Cross–Blue Shield and GHA (age sex-adjusted)

Diagnostic category	Admissions per 1000 member years BC–BS	GHA	Differential BC–BS—GHA	237 Category code equivalents	Estimated MCC1 ($1969)	Estimated MCC2 ($1969)	Estimated cost saving based on MCC1 ($1969)	Estimated cost saving based on MCC2 ($1969)
Disorders of menstruation	2.4	0.3	2.1	158	269.67	319.18	566.3	670.3
Acute respiratory infections	1.7	0.3	1.4	104-105	259.20	323.60	362.9	453.0
Hypertrophy of tonsils and adenoids, chronic tonsillitus	5.9	1.5	4.4	110	243.31	265.81	1,070.6	1,169.6
Arthritis, rheumatism, gout	0.9	0.3	0.6	055(0.35), 177-179	397.60	658.90	238.6	395.3
Pneumonia	1.2	0.4	0.8	106	299.83	431.28	239.9	345.0
Bronchitis, emphysema, and other diseases of respiratory system	1.4	0.5	0.9	107-108, 114-117	313.81	456.07	282.4	410.5
Spirochetal, parasitic and other infectious disease	1.1	0.4	0.7	015, 014, 016, 002(0.95)	272.27	352.02	190.6	246.4
Other diseases of breast and female genital system	8.9	3.4	5.5	039, 042-043, 041(0.3), 153-159, 152(0.4)	295.77	372.60	1,626.7	2,049.3
Selected diseases of urinary tract	7.5	2.9	4.6	045(0.05), 141-148	376.32	470.31	1,731.1	2,163.4
Diseases of skin and subcutaneous tissue	2.4	1.0	1.4	045(0.2), 040,047(0.1), 172-176, 199(0.2)	301.71	422.58	422.4	591.6

TABLE 23 continued

Diagnostic category	Admissions per 1000 member years: BC-BS	GHA	Differential BC-BS—GHA	237 Category code equivalents	Estimated MCC1 ($1969)	Estimated MCC2 ($1969)	Estimated cost saving based on MCC1 ($1969)	Estimated cost saving based on MCC2 ($1969)
Diseases of liver and pancreas	0.7	0.3	0.4	135-136, 140	395.16	624.60	158.1	249.8
Diseases of thyroid and other endocrine glands	0.9	0.4	0.5	048-050, 052	368.06	540.41	184.0	270.2
Chronic cystic breast disease	1.1	0.5	0.6	152	269.96	322.19	162.0	193.3
Psychotic and Psychoneurotic disorders	1.3	0.6	0.7	060-061, 063, 062(0.4)	397.99	646.21	278.6	452.3
Other diseases of circulatory system	3.3	1.6	1.7	045(0.15), 087(0.1), 058(0.55), 094-103	354.14	522.11	602.0	887.6
Diabetes mellitus	1.0	0.5	0.5	051, 228(0.05)	344.71	530.71	172.4	265.4
Selected diseases of upper respiratory tract	1.0	0.5	0.5	045(0.05), 111-113	326.37	389.58	163.2	194.8
Selected diseases of heart	1.3	0.7	0.6	085(0.5), 086, 090	373.55	581.27	224.1	348.8
Diseases of upper gastro-intestinal system	2.1	1.1	1.0	120-126	328.76	479.27	328.8	479.3
Diseases of gallbladder and biliary ducts	1.1	0.6	0.5	137-139	339.75	484.96	169.9	242.5
Other diseases of intestines and peritoneum	2.0	1.1	0.9	045(0.15), 131-134, 173	324.58	465.47	292.1	418.9
Hyperplasia of prostate and prostatitis	0.7	0.4	0.3	149, 151(0.3)	389.53	582.66	116.9	174.8
Diseases of the eye	1.8	1.0	0.8	076-081	379.24	484.84	303.4	387.9

TABLE 23 continued

Infectious diseases caused by viruses	0.9	0.5	0.4	008-013	294.04	399.47	117.6	159.8
No classifiable diagnosis or no illness	4.0	2.4	1.6	047, 206-207 232-234	295.05	364.83	472.1	583.7
Osteomyelitis and other diseases of bone and joint	1.7	1.0	0.7	045(0.15), 180, 182(0.95),181(0.05)	343.21	495.32	240.2	346.7
Other diseases of musculoskeletal system	1.0	0.6	0.4	045(0.05), 183 184(0.4)	293.38	382.61	117.4	153.0
Arteriosclerotic and other heart disease	1.6	1.0	0.6	087(0.9), 088-089	371.80	573.76	223.1	344.3
Injury to internal organs	1.8	1.1	0.7	216-218, 224-225, 227	270.78	353.61	189.5	247.5
Appendicitis	1.1	0.7	0.4	127	280.09	360.29	112.0	144.1
Fibromyoma of uterus	1.8	1.2	0.6	041	326.35	430.09	195.8	258.1
Delivery	17.9	13.0	4.9	165-170, 235, 201(0.2), 202(0.1)	301.82	376.23	1,478.9	1,843.5
Allergic disorders	0.8	0.6	0.2	109,113(0.05), 175(0.5), 176(0.15)	294.28	406.24	58.9	81.2
Fractures, dislocations, and sprains of selected sites	3.4	2.6	0.8	208-215	347.68	528.71	278.1	423.0
Diseases of ear	1.0	0.8	0.2	082-084	305.47	372.04	61.1	74.4
Inflammatory and other diseases of central nervous system	0.8	0.5	0.3	070-074 044, 068, 069(0.50)	394.98	642.41	118.5	192.7
Other diseases of appendix, hernia, and intestinal obstruction	4.6	3.8	0.8	096(0.05), 128-130	306.46	415.72	245.2	332.6

TABLE 23 continued

Diagnostic category	Admissions per 1000 member years: BC–BS	GHA	Differential BC–BS—GHA	237 Category code equivalents	Estimated MCC1 ($1969)	Estimated MCC2 ($1969)	Estimated cost saving based on MCC1 ($1969)	Estimated cost saving based on MCC2 ($1969)
Malignant neoplasms	1.6	1.4	0.2	017-036	458.64	727.62	91.7	145.5
Complications of pregnancy	5.0	4.4	0.6	160-164, 205(0.1), 200	286.73	332.07	172.0	199.2
Congenital anomalies	1.4	1.3	0.1	184(0.55), 185-199	398.11	570.95	39.8	57.1
Birth injuries and diseases of early infancy	0.9	1.0	–0.1	205(0.8), 203 201(0.35), 204 202(0.9), 236	414.88	578.22	–41.5	–57.8
Other diseases of male genital organs	1.4	1.6	–0.2	150, 151(0.7)	269.87	329.03	–54.0	–65.8
Adverse effects of chemical substances and other trauma	0.7	0.8	–0.1	228-231	286.78	381.95	–28.7	–38.2
Wounds and burns	1.0	1.5	–0.5	219-223, 226	279.95	385.49		–192.7
All other diagnoses	13.6	7.3	6.3	064-066, 171, 181(0.9), 182(0.05), 001, 002(0.05), 004-007, 038, 014(0.75), 037, 053-054, 055(0.65), 056-058, 059, 062(0.55), 066(0.2) 091-093, 075, 137(0.25)	373.80	564.23	2,354.9	3,554.6
Total							16,189.6	21,846.5

SOURCE: Columns 1 and 2 from Riedel et al. (1975); column 3 = 1–2; columns 4 to 8, see text.

TABLE 24

Patient days per 1000 member years and expenditure differentials: Blue Cross–Blue Shield and GHA (age sex-adjusted)

Diagnostic category	Patient days per 1000 member years: BC–BS	Patient days per 1000 member years: GHA	Differential BC–BS—GHA	Estimated MCD1 ($1969)	Estimated MCD2 ($1969)	Estimated cost differential based on MCD1 ($1969)	Estimated cost differential based on MCD2 ($1969)
Disorders of Menstruation	7.7	0.8	6.9	28.41	39.69	196.0	273.9
Acute respiratory infections	7.2	1.1	6.1	22.40	32.99	136.6	201.2
Hypertrophy of tonsils and adenoids, chronic tonsillitis	8.7	2.6	6.1	24.65	36.08	150.4	220.1
Arthritis, rheumatism, gout	13.3	4.9	8.4	34.33	46.50	288.4	390.6
Pneumonia	9.7	3.3	6.4	25.51	36.40	163.3	233.0
Bronchitis, emphysema and other diseases of respiratory system	12.7	3.9	8.8	27.73	39.08	244.0	343.9
Spirochetal, parasitic, and other infectious diseases	7.4	2.7	4.7	26.59	37.82	125.0	177.8
Other diseases of breast and female genital system	47.7	19.8	27.9	31.83	43.25	880.1	1,206.7
Selected diseases of the urinary tract	36.0	14.2	21.8	75.66	88.11	1,649.4	1,920.8
Diseases of skin and subcutaneous tissue	12.2	7.0	5.2	28.98	40.82	150.7	212.3
Diseases of liver and pancreas	9.9	3.7	6.2	33.47	45.60	207.5	282.7
Diseases of thyroid and other endocrine glands	7.4	2.8	4.6	40.40	53.55	185.8	246.3
Chronic cystic breast disease	3.1	1.1	2.0	29.37	41.08	58.7	82.2
Psychotic and psychoneurotic disorders*	27.9	8.3	19.6 (13.5)	34.88	46.72	(470.9)	(630.7)
Other diseases of circulatory system	31.6	14.0	17.6	33.99	46.12	598.2	811.7

TABLE 24 continued

Diagnostic category	Patient days per 1000 member years			Estimated MCD1 ($1969)	Estimated MCD2 ($1969)	Estimated cost differential based on MCD1 ($1969)	Estimated cost differential based on MCD2 ($1969)
	BC–BS	GHA	Differential BC–BS—GHA				
Diabetes mellitus	11.5	5.4	6.1	28.32	39.82	172.8	242.9
Selected diseases of upper respiratory system	3.0	2.1	0.9	58.82	71.42	52.9	64.3
Selected diseases of the heart	14.5	9.6	4.9	32.99	45.32	161.7	222.1
Diseases of upper gastro-intestinal system	21.6	10.7	10.9	28.85	40.16	314.5	437.7
Diseases of gallbladder and biliary ducts	13.3	5.5	7.8	30.48	41.70	237.7	325.3
Other diseases of intestines and peritoneum	14.6	8.6	6.0	30.16	41.79	181.0	250.7
Hyperplasia of prostate and prostatitis	4.3	4.2	0.1	37.59	50.05	3.8	5.0
Diseases of the eye	7.0	5.1	1.9	60.28	73.57	114.5	139.8
Infectious diseases caused by viruses	8.1	2.7	5.4	30.01	41.73	162.1	225.3
No classifiable diagnosis or no illness	23.1	14.5	8.6	37.84	50.02	325.4	430.2
Osteomyelitis and other diseases of bones and joints	20.2	10.2	10.0	35.56	47.96	355.6	479.6
Other diseases of musculoskeletal system	4.2	3.9	0.3	33.13	45.04	9.9	13.5
Arteriosclerotic and other heart disease	20.4	17.1	3.3	30.31	41.81	100.0	138.0
Injury to internal organs	12.5	5.6	6.9	26.69	38.39	184.2	264.9
Appendicitis	6.0	4.6	1.4	26.22	37.39	36.7	52.3
Fibromyoma of uterus	15.4	9.8	5.6	34.45	45.94	192.9	257.3
Delivery	71.7	55.2	16.5	34.49	45.90	569.1	757.4
Allergic disorders	5.2	3.7	1.5	28.82	40.51	43.2	60.8

TABLE 24 continued

Diagnostic category	Patient days per 1000 member years BC–BS	GHA	Differential BC–BS—GHA	Estimated MCD1 ($1969)	Estimated MCD2 ($1969)	Estimated cost differential based on MCD1 ($1969)	Estimated cost differential based on MCD2 ($1969)
Fractures, dislocations, and sprains of selected sites	31.5	30.9	0.6	30.67	42.40	18.4	25.4
Diseases of ear	2.8	3.4	–0.6	44.24	56.59	–26.5	–34.0
Inflammatory and other diseases of central nervous system	8.2	5.7	2.5	38.79	51.91	97.0	129.8
Other diseases of appendix, hernia, and intestinal obstruction	27.4	21.1	6.3	29.64	41.16	186.7	259.3
Malignant neoplasms	12.2	7.0	5.2	40.38	52.85	210.0	274.8
Complications of pregnancy	15.4	13.6	1.8	42.06	54.06	75.7	97.3
Congenital anomalies	9.8	9.0	0.8	57.66	71.53	46.1	57.2
Birth injuries and diseases of early infancy	7.6	17.0	–9.4	45.57	57.65	–428.4	–541.9
Other diseases of male genital organs	5.6	5.9	–0.3	27.97	39.43	–8.4	–11.8
Adverse effects of chemical substances and other trauma	3.6	5.5	–1.9	28.53	40.56	–54.2	–77.1
Wounds and burns	6.9	8.2	–1.3	24.81	36.20	–32.3	–47.1
All other diagnoses	135.3	71.2	64.1	35.74	47.78	2,290.9	3,062.7
Totals						11,098.0	14,795.6

* Because of differences in benefit coverage between the BC–BS and GHA plans which would tend to impart a downward bias to the GHA average length of stay for this category, the days stay differential (in brackets) and cost differentials are based on an assumption of equal ALS for the two plans. See text for details.

SOURCES: — Patient days from Riedel *et al.* (1975, 27); MCD1 and MCD2 based on Table 13 and the 237 Code equivalents listed in Table 23.

this category was constructed as

$$\text{MCC1} = (\text{MCC1}_{177}\cdot C_{177} + \text{MCC1}_{178}\cdot C_{178} + \text{MCC1}_{179}\cdot C_{179} + \text{MCC1}_{055}\cdot(.35)C_{055})/(C_{177} + C_{178} + C_{179} + (.35)C_{055}).$$

As is evident from Table 23, just over one-half of the forty-five diagnostic categories taken from this study required similar applications of the fine ICDA breakdown.

Moreover, there were benefit differences for another of the original forty-six categories – psychotic and psychoneurotic disorders. 'No distinction in hospital benefits was made in the BC-BS plan for patients admitted to member hospitals with nervous and mental diseases while they ceased for GHA members when a final diagnosis of nervous and mental disorder requiring long-range care was made' (Riedel et al. 1975, 1-2). This fact suggested that inclusion of this admission rate differential in Table 23 was appropriate, though similar treatment of this category in Table 24 would be somewhat suspect, since the 52 per cent difference in length of stay (ibid., 23) was undoubtedly partially induced by benefit coverage. Complete exclusion of the category from Table 24 however could be equally suspect if we are willing to accept its inclusion in Table 23. In an admittedly crude attempt to estimate a days stay differential in a fictitious equal-benefits situation, a hypothetical differential of 13.5 days was calculated by retaining the admissions differential but also assuming equivalent inter-plan average lengths of stay for this diagnosis.[12]

When our marginal costs are linked with these utilization differentials the results based on days stay and on admissions are inconsistent with those from the studies described earlier. Take the intra-study results first. The aggregate expenditure differential based on our MCC1 estimates is more than 45 per cent larger than that based on MCD1, a much greater discrepancy than arose in the Hastings-based results and in the opposite direction. Fortunately, there is a fairly obvious and plausible explanation for this wide divergence. We have seen (Table 6) that the average length of stay of all separations from the 182 hospitals in our sample over the six years of analysis was approximately 9.75 days. This Ontario experience was built into the MCC estimates and particularly into the relationships between MCC1 and MCD1. But the ALS for the FEHBP population upon which Riedel et al. based their study was much lower – 6.5 days. If our

12 This seemed reasonable because there was no significant difference in the overall ALS for subscribers to the two plans.

TABLE 25

Expenditure differentials based on alternative cost measures applied to utilization differentials from Riedel et al. (1975)

	Admissions	Days stay
Utilization differential *	$ 52.2	$ 321.5
(1) Total operating cost per admission or days stay (1969)	557.25	52.61
(2) Inpatient cost per admission on days stay (1969)	442.42	41.77
(3) Estimated cost differential based on (1)	29,088.5	16,914.1
(4) Estimated cost differential based on (2)	23,094.3	13,429.1
(5) Diagnosis-specific marginal-cost-based expenditure differential estimates	16,189.6	11,098.0

* age-sex adjusted

MCC1/MCD1 ratio had been 6.5:1 rather than 9.25:1 ($324.84/$35.06), we might have expected an admissions-based expenditure differential in the neighbourhood of $(6.5/9.25) \times 16189.6 = \$11,376.5$, almost identical to the differential based on days stay.

The result of approximately $11,000 is also remarkably consistent with the days stay figure of $10,270 calculated in Table 17 for the Sault Ste Marie CHC, although it is more than 35 per cent higher than that study's result based on discharges. Since the FEHBP utilization data are for entire subscriber populations (19,402 BC-BS members and 36,629 GHA members; Riedel et al. 1975, 11), the results of Tables 23 and 24 are directly comparable only with the Hastings study and the Densen report. The figure in the latter study was less than half the $11,000 estimate of Table 24.

Any number of factors, such as methodology, diagnostic groupings, behavioural differences across PGP/CHC settings, differences across PGP/CHC settings in responsibility for members' hospital utilization, and actual differences in illness incidence might underly the fact that we have obtained a range of results. But the lack of exactly matching diagnostic categories makes further analysis difficult. For example, whereas all benign neoplasms were classed as 'neoplasms' or 'benign neoplasms' in the Hastings and Densen studies, Riedel allocated benign neoplasms to the disease category covering the part of the body affected; thus, benign neoplasms of the eye are grouped with 'diseases of the eye'. This may be the least useful classification for purposes of grouping 'like cost' diagnoses, but it is all that study provided.

Before leaving this discussion it is worth pointing out once again the difference in estimates based on our diagnosis-specific marginal costs and those based

on cruder aggregate figures. Table 25 duplicates Table 19 but for the FEHBP data base. The overestimate from applying average non-diagnosis-differentiated costs is again illustrated most vividly in the admissions column, but the directions and magnitudes of bias are quite similar to those illustrated in Table 19.

The analysis to this point suggests a potential yearly hospital expenditure saving of between $5 and $11 a person enrolling in a PGP/CHC plan, and between $11 and $19 a person contacting a PGP/CHC physician at least once. In the final chapter these results are considered in somewhat more detail and attention is focused on the estimates based on concurrent adjustment of bed stock.

7

Hospital expenditure differentials – implications and summary

Applying our diagnostic marginal costs to the four sources of utilization differentials resulted in a variety of gross hospital cost-saving estimates. The results based on the marginal costs without concurrent adjustment of bed stock (MCC1 and MCD1) are summarized briefly in Table 26.

In comparing results based on different sets of utilization data, one must pay particular attention to any population exclusions (i.e. maternity) or absence of age-sex standardization. For example, Hastings apparently undertook no standardization, although 'the age-distribution of GHC members is so close to that of persons covered by the IIP that crude rates can be considered comparable' (Hastings et al. 1973, 93). With regard to maternity care, the hospital discharge rates did not include the discharge of newborns but did include the discharge of their mothers. The only data available in a disaggregated form in McPhee (1973) were non-standardized though age-sex standardization in that study had very little effect on, for example, the aggregate discharge rates.[1] The exclusion of two specific groups – registered Indian patients and maternity admissions aged 15-44 – also had little effect on the percentage differentials (McPhee 1973, 16). Thus, both these groups were included in our analysis, and inclusion of the latter ensures comparability with the Hastings figures.[2]

1 See McPhee (1973, 12), in particular Table 1. For example, the aggregate percentage discharge differences between the clinic and non-CHA subscribers changed by at most 3 per cent when age-sex standardized rates were used. Thus, Prince Albert CHA patients were reported to have experienced 25 per cent fewer discharges than non-CHA patients, while the corresponding standardized figure was 22 per cent. Changes for the other two clinics were even smaller.

2 It has been suggested that exclusion of maternity-related admissions would have been the correct methodology, as 'demand' of this nature is beyond physician influence, and physician influence over treatment regimens as modified by organizational mode and method of payment, was suggested in Chapter 2 to be of considerable importance to the hospital utilization differentials. While that argument has merit, two factors influenced our decision to leave this category in. McPhee suggests that exclusion of maternity-related hospitalization 'may not be

TABLE 26

Summary of expenditure differential estimates based on MCC1 and MCD1

Source of utilization differentials	Hospital expenditure differentials per 1000 population based on		Comments
	MCC1	MCD1	
1 Hastings et al. (1973)	$ 8,286.28	$10,272.24	Based on entire subscribing populations including maternity cases
	15,698.85		Based on estimate of number of subscribers who visited a physician at least *once* during study period, including maternity cases.
2 McPhee (1973) Regina	13,203.48		Based on subscribers who visited a physician at least *twice* in study period, maternity cases included.
Saskatoon	16,840.55		
Prince Albert	22,880.23		
Regina	11,222.96		Based on estimate of number of subscribers who contacted a physician at least *once* during study period; maternity cases included.
Saskatoon	14,314.47		
Prince Albert	19,448.20		
3 Densen et al. (1960)	5,660.00		Based on actual study populations, exclusive of maternity and related care, composition of which was 80% female, 20% male.
	4,225.00		As above, but assuming a 50-50 male/female population composition.
4 Riedel et al. (1975)*	16,189.6	11,098.00	Based on total subscribing populations; includes maternity cases.

* The large difference between the figures based on MCC1 and MCD1 derives from the difference in length of stay between Ontario patients and this particular study population. See Chapter 6 for details.

Densen et al. (1960) considered male and female admission patterns separately. Within each sex, adjustments were made for age. As noted in the previous chapter, maternity care cases were not included in the study population's admission experience breakdown, because such care was not an insured service under the union plan. The FEHBP study data did include admission rates for deliveries, complications of pregnancy, and so on. Furthermore, the rates used in Chapter 6 were age-sex adjusted.

The terms 'admissions,' separations,' and discharges' have been employed almost interchangeably so that results based on different types of utilization rates have been compared. Obviously these terms are not precisely equivalent. While the difference between admissions and either discharges or separations is clear, the distinction between separations and discharges is less obvious: separations are equivalent to the sum of discharges and in-hospital deaths.

Although bias is possible when admission rate results are compared with those from discharges or separations, two things should be kept in mind:

– in each study the same measure was used for both sides of the comparison – the group receiving care from the clinic (or PGP) and the 'control' group;
– within any hospital or group of hospitals, admissions, separations, and discharges will bear a close relation to each other as long as there is no change in hospital use (say from acute to chronic care).[3]

upheld retrospectively because CHA clinics, through their family life education programs, appear to be influencing the frequency of maternity-related hospitalization' (McPhee 1973, 10). While one might still argue convincingly for the exclusion of admissions for deliveries, extension to complications of pregnancy is somewhat more tenuous. Exclusion of the latter would leave us vulnerable to arguments for excluding almost any other category. As the date in Hastings' study are not disaggregated sufficiently to allow separation of these specific case types, the relevant diagnostic categories in the Saskatchewan data were retained in our analysis to facilitate comparability.

3 The following statistics for adults, children and newborns in all Ontario hospitals illustrate this point:

	1974	1969
Admissions	1,517,906	1,276,002
Discharges	1,445,478	1,242,021
Separations	1,481,481	1,275,430

Separations and admissions were less than 2.5 per cent apart, while admissions and discharges differed by approximately 5 per cent in 1974 but closer to 2.5 per cent in 1969 (*Ontario Hospital Statistics 1969 and 1974*).

For these reasons no significant bias of this type is likely to have influenced the comparisons.

While the expenditure differentials based on the Hastings, McPhee, and Riedel studies were of the same order of magnitude, the HIP study suggests much smaller cost differentials. Recall the aggregate utilization differentials (Table 4), which are in the 18 to 24 per cent range for all but one of the six comparisons (Hastings, three in McPhee, Densen (1969), and Riedel); the one aberrant figure belongs not to the HIP study but to the FEHBP comparison. The aggregate differential reported by Riedel, even after exclusion of the diagnostic category for which benefit coverage was not equivalent, was over 40 per cent. While it is particularly interesting, therefore, to note the close similarity of the expenditure differentials based on the FEHBP and Sault Ste Marie studies, a comparison of percentage utilization differentials does not help rationalize the results based on Densen's utilization data. Table 4 suggests that the explanation lies with the relatively low admission rates reported by Densen for the 'control' population: whereas the HIP control rate was 88.3, the FEHBP control rate was 121.8, and the Prudential subscribers (control for the Sault Ste Marie CHC) were discharged at a rate above 135 per 1000 person-years. Thus, the *absolute* aggregate differential for the 1960 HIP study is only 18 admissions per 1000 subscribers, compared to a differentials range of from 27 to 65 admissions (or discharges) per 1000 subscribers in the other five comparisons. While this does not explain the entire difference between the Hastings and Densen results (the aggregate utilization differential ratio of two-thirds (18/27) still exceeds the ratio of their expenditure differentials; see Table 26), further reconciliation is impossible without information about the sex composition of the Sault study populations.

It would be difficult and hazardous to try to generalize about the diagnosis-specific reasons for the clinics' lower hospital utilization. While Sault Ste Marie subscribers incurred significantly lower costs than their control counterparts in the respiratory diseases category, a similar differential is evident for only one of the three Saskatchewan clinics (Prince Albert). The adjusted (to subscribers receiving physician care) neoplasms expenditure differential for the Sault Ste Marie study was \$693, while the corresponding figure for the Regina clinic was approximately \$1773 (2086 × 0.85).

The American evidence is equally trendless. The Densen (1960) study reported female tonsillectomy and adenoidectomy rates among the HIP subscribers to be more than 50 per cent lower than the corresponding GHI rates. Yet that utilization differential translates into an expenditure difference of \$136 per 1000 female subscribers – fourteen cents per subscriber – based on MCC1. A good deal of the lower costs for female members originated in the neoplasms category, whereas male HIP members incurred higher costs than their GHI

counterparts in this category. It is interesting that respiratory diseases showed a total difference of approximately $1.78 less for male HIP subscribers. Since the total male differential was $1.84, HIP males incurred costs equivalent to those of GHI males for the rest of the diagnoses taken as a group. For the FEHBP study (Tables 23 and 24) the largest single category cost difference is in 'all other diagnosis', which obscures the effects of specific diagnostic entities.

In sum, no consensus emerges regarding a diagnosis (or diagnoses) consistently responsible for the cost differentials. The widely acclaimed reduction in elective surgery (such as T & As) for CHC / PGP patients does not emerge as a consistent factor. The translation into expenditure differentials is often less dramatic than the percentage utilization differences. Out of a total $11,098 differential per 1000 FEHBP employees (basis MCD1, Table 24), only $150, or fifteen cents a subscriber per year, derives from 'hypertrophy of tonsils and adenoids, and chronic sinusitis,' and this in spite of a BC-BS days stay rate for these conditions that is 235 per cent higher than for the GHA subscribers.

Table 26 unfortunately suggests little basis for incisive conclusions. A patient receiving primary care through a CHC in Ontario could apparently expect to incur anywhere from $4.20 to $16.20 less in hospital costs than another receiving such care through private fee-for-service practice, although there seems to be more clustering around the middle of this range. The range increases to $11.00-$19.40 when only patients receiving some primary care are considered (all figures expressed in 1969 dollars; see Chapter 6, fn. 11). Assuming, rather unrealistically, that the entire Ontario population had access to community health centres, and furthermore could choose between such centres and private practitioners for their primary care, the following extrapolation might apply.

The population of Ontario in 1969 was 7,385,000 (Ontario 1978). Assume that the entire population chooses to be served by CHCs. The possible hospital expenditure savings would be between $31 million and $119 million.

Let us optimistically assume a possible saving of $80 million ($11 a person). By applying the hospital cost index of Table C.2 and incorporating the 1974 Ontario population of 8,094,000 we obtain a 1974 dollar equivalent (to the $80 million figure) of $143 million. (We shall overlook the plight of the hapless private practitioners who are suddenly left without patients but who receive their own care through CHCs).

This, then, is as far as the cost analysis itself allows us to proceed. While $143 million is no paltry sum, it represents only a small proportion (8.4 per cent) of Ontario's hospital expenditures in that year and is tiny beside the total provincial health expenditures for 1974 of $3.8 billion. Unfortunately savings of even that much are unlikely. For public policy the amount of achievable hospital expenditure savings is less important than the scope for savings in total health

care expenditures that do not diminish quality. A more general analysis of that type is not attempted here, but a few possibilities are considered briefly below.

Assuming that there may be an overexpenditure of \$143 million (in 1974 dollars) on hospital care in Ontario that can be eliminated through a reorganization of primary care delivery, and assuming further that this overexpenditure is primarily the result of excess admissions, what becomes of all the patients who would have been admitted under the present system? It is likely that such cases could be divided into two groups: patients who, for whatever reasons, did not require hospitalization and in fact had self-limiting conditions that required no particular medical attention; and patients who, while genuinely in need of *medical* attention, could have been treated with equal efficacy on an ambulatory basis. For patients in the first category the estimated possible hospital expenditure savings will be a close approximation of actual health care expenditure savings. Cases of the second type could be further divided into those requiring treatment identical to the expected hospital treatment, but received on an outpatient basis, and those needing different and perhaps less costly treatment, again on an ambulatory basis. For both sub-groups we must clearly subtract actual treatment cost from potential savings to determine the achievable savings. In many cases, perhaps only the 'hotel cost' and a portion of the nursing cost segments of hospital expenditures would in fact be 'saved.'

For a better estimate of the health care expenditure savings possible from an organizational change in the delivery of primary medical care we would need information on the relative sizes of the two categories of excess hospital cases described above and data on the relative shares of hospital expenditures taken up by nursing, medical treatment, and hotel costs.

One recent study that provides some American evidence on the latter is Elnicki's (1976) estimation of the savings possible from substituting outpatient for inpatient care. He reproduced a Connecticut Hospital Association departmental cost allocation, which showed hotel services to be 16.5 per cent of total hospital costs (p. 225).

If 'hotel costs' were the only savings realized (i.e. if all 'saved hospital' patients required identical treatment outside the inpatient ward), the 16.5 per cent figure would shrink our potential savings estimate (in 1974 dollars) of \$143 million to \$23.6 million. In other words, if all hotel-type costs for the 'excess' care could be eliminated but all other treatment-related expenses remained (i.e. all inappropriate inpatient cases are assumed to require equivalent ambulatory treatment), the potential savings essentially disappear – \$23 million is little more than 1 per cent of total Ontario hospital expenditures in 1974.

To assume that hotel costs represent the only savings is, however, unrealistic. It is certainly plausible to assume that the shift to ambulatory care would also

reduce nursing costs both because some patients would be in the 'no care required' category noted above and because some of the second-category patients could safely use less intensive nursing care. Statistics Canada (Canada 1976a) classified 36 per cent of Ontario public hospitals' operating expenses as nursing expenses. The remaining 64 per cent of operating expenses is broken down into 'diagnostic and therapeutic,' 'educational programs,' and 'administration and support' categories. Since hotel costs will fall largely within the latter category, and have already been assumed as 'saved costs,' there is likely little more to be squeezed from those three hospital service sectors.

It is, of course, unrealistic to assume that *all* nursing costs would be eliminated through ambulatory care substitution. If an assumption is made that between hotel, nursing, and administration costs an average of 60 per cent of the gross potential hospital savings per avoided admission would materialize as net health care cost savings, the $143 million figure becomes $86 million in 1974 dollars.

Of course the reader may wish to substitute alternative sets of figures into this framework to derive cost saving estimates, but a number of things should be evident. If the $143 million is accepted as a reasonable estimate of potential hospital-based savings, then health care expenditure savings deriving from reduced hospitalization will likely be between $40 million and $100 million, with the latter figure allowing some scope as well for treatment cost savings. Even $100 million represents only 2.6 per cent of Ontario's health expenditures in 1974, and that figure is crucially dependent on two additional assumptions: that freed-up beds are not refilled with new admissions that would otherwise have been treated on an ambulatory basis or left untreated; and that CHCs/PGPs do not derive their lower hospital-utilization rates by increasing the intensity of ambulatory treatment for *all* their patients, compared to non-group patients. If the first assumption is not realistic, then of course total health costs may increase as a result of the expansion of the CHCs. Increased ambulatory care would also reduce the 2.6 per cent figure.

The evidence on the second assumption is mixed. One would expect yearly ambulatory care to be above average for patients that would have been hospitalized had they received their primary care in a non-CHC/PGP setting. But if the general CHC/PGP populations are subject to increased non-inpatient servicing, this will erode any potential cost savings. Luft (1978a) gathers some of the germane evidence and concludes that 'HMO enrollees receive at least as many (or more) ambulatory visits (per person) as enrollees in conventional plans ... [The findings] suggest that HMOs do not save money by reducing ambulatory visits' (p. 1338). Of course 'ambulatory visits' is a crude proxy for intensity of ambulatory treatment, and those per person rates will include rates for patients who might otherwise have been hospitalized, but Luft's review at least suggests that

the 2.6 per cent figure is not likely to increase when aggregate ambulatory services are incorporated into the analysis.

With respect to the first assumption, whether for demand- or supply-induced reasons, bed supply and utilization rates are generally found to be highly correlated. This suggests that cost savings may be crucially dependent on bed closures. The second set of figures derived in the previous chapter allow us to address this issue. Table 27 brings forward from Chapter 6 the figures comparable to those in Table 26 but based on MCC2 and MCD2. These alternative marginal cost estimates are based on concurrent case mix and bed supply shifts designed to maintain a constant hospital occupancy rate.

The figures that use bed stock adjustment suggest that a longer-run strategy of closing beds freed by CHC-induced reductions in inpatient care could increase yearly cost savings by around 35 per cent. In 1974 terms that raises the $143 million to a potential saving of $193 million, and the estimated $100 million net health care expenditure savings to $135 million, or about 3.5 per cent of Ontario's total 1974 health expenditures. The maximum figure, assuming the original potential of $143 million in savings all materialized, would be about 5 per cent. It appears, then, that appropriate bed supply policy enacted in conjunction with a reduction in admissions could increase savings by around 35 per cent, but the estimated total impact on aggregate Ontario health care expenditures would still not be overwhelming. Whether a 3.5 per cent reduction is a goal worthy of vigorous pursuit is ultimately a political question to be answered by weighing the potential gain against the costs inherent in an expanded CHC program as well as non-cost-related factors. Of course there may be other sources of health care cost savings within the CHC organization.

This analysis has focused only on potential cost savings resulting directly or indirectly from a reduction in inpatient hospital utilization by CHC subscribers. Furthermore, the estimates have been based on utilization experiences reported from many variants of PGPs and CHCs. In effect, we have answered parts of three specific questions. If the intent is to estimate the potential and theoretical role of the PGPs/CHCs in reducing hospital and health care expenditures through reduced hospitalization, one should be seeking to determine the impact of a broadly based 'generic PGP program.' In this type of program the group and its providers would be at full financial risk for all types of care received by its well-defined roster of patients, where patients prepay for care and practitioners are reimbursed on a non-fee-for-service basis. The effect of a general extension of CHCs in Ontario under the present financing and enrolment arrangements is a quite distinct question. Finally, the third question concerns the *overall effect on expenditures* of CHCs/PGPs, and to answer this, we must consider potential cost savings by means other than a reduction in inpatient care.

TABLE 27

Summary of expenditure differential estimates based on MCC2 and MCD2

Source of utilization differentials		Hospital expenditure differentials per 1000 population based on		Comments
		MCC2	MCD2	
1 Hastings et al. (1973)		$10,777.77	$13,848.01	Based on entire subscribing populations including maternity cases
		20,603.73		Based on estimate of number of subscribers who visited a physician at least *once* during study period, including maternity cases.
2 McPhee (1973)	Regina	18,391.72		Based on subscribers who visited a physician at least *twice* in study period, maternity cases included.
	Saskatoon	23,218.69		
	Prince Albert	29,943.89		
	Regina	15,632.96		Based on estimate of number of subscribers who contacted a physician at least *once* during study period; maternity cases included.
	Saskatoon	19,735.89		
	Prince Albert	25,452.31		
3 Densen et al. (1960)		7,693.48		Based on actual study populations, exclusive of maternity and related care, composition of which was 80% female, 20% male.
		5,713.3		As above, but assuming a 50-50 male/female population composition.
4 Riedel et al. (1975)*		21,846.5	14,795.6	Based on total subscribing populations; includes maternity cases.

* The large difference between the figures based on MCC2 and MCD2 derives from the difference in length of stay between Ontario patients and this particular study population. See Chapter 6 for details.

None of the four utilization studies applied in the previous chapter was without one or more methodological problems that compromised any attempt to address the 'generic program' question. While the data from the Hastings study pre-dated universal health insurance in Canada so that well-defined subscriber populations formed the base of comparison, universal hospital insurance was in existence. This meant, of course, that neither the GHA clinic nor the private control group insurer was responsible for the costs of hospital care incurred by members. Furthermore, as noted earlier, the sample sizes upon which utilization differentials were based were so small as to negate much of the advantage of developing diagnosis-specific marginal costs. The McPhee data shared this latter problem, but also had the equally serious problem of reporting rates for user populations rather than subscriber populations. The author had little choice since that study derived from the universal health insurance period.

The data in the HIP study (Densen et al. 1960) are subject to similar qualifications when set against a 'generic PGP' ideal. In particular, the authors state that for both the PGP and control groups 'hospitalization was provided through Blue Cross' (p. 1711): the PGP was not at risk for the hospital costs incurred by its enrollees. Furthermore, HIP is composed of more than thirty distinct groups of providers in which 'the individual physicians may have private practices in addition to their HIP practice' (ibid., 1712). While the GHA plan in the FEHBP study was at risk for inpatient services provided to its members, the providing practitioners themselves were not.

What effect are these factors likely to have? The Kaiser Permanente Health Plan is a close operating example of the 'generic model.' To a considerable degree it restricts hospitalization of its subscribers to its own hospitals, and practitioners are offered incentives to treat on an ambulatory basis wherever possible. Another example is the Group Health Cooperative of Puget Sound. Unfortunately, neither plan has been the subject of a detailed comparative utilization study that published diagnostically disaggregated data. Such information is essential for any definitive assessment of the importance of 'generic degree'. Gaus et al. (1976) included the latter plan as one of eight PGPs in their study of Medicaid recipients. Its utilization rate (basis admissions), at 49 per cent less than its control group, was actually at the low end of the 44-82 per cent differentials reported in favour of the eight plans. While one study of a restricted segment of the population that provided no diagnosis-specific information is not sufficient evidence on which to base any conclusions about the 'representativeness' of our cost savings estimates, it certainly does not make one want to increase those estimates.

What that single piece of evidence does highlight is the general lack of information about the effect on expenditures of 'generic PGPs' in Canada. Only

with further controlled experiments will it be possible to refine the estimates developed here. In Ontario, where there is universal health insurance, and where each resident is free to choose providers, a special effort would be necessary to ensure that the essential characteristics of the generic plan were incorporated into any such trials. But the dearth of information about the potential hospital-related cost savings inherent in PGPs/CHCs suggests that such experiments are of paramount importance.

The analysis in this study sheds little light on the second question, i.e. the impact of a widespread CHC program under Ontario's current organization and financing arrangements. Because of the freedom of patients to 'shop' for providers, it is likely that cost savings (if any) would be significantly less than the conservative estimates offered above. That serves to re-emphasize the need to experiment with the CHC/PGP concept in Canada and, if the results suggest significant cost savings, to develop ways in which to better accommodate widespread implementation of this delivery system.

As for the third question, even if savings caused by a reduction in hospital utilization are no more than 5 per cent and ambulatory care for other patients is approximately unchanged, the total savings in health care costs from a complete shift to CHCs will be crucially dependent on the providers' incomes. The relationship between aggregate physician salaries and other CHC expenses on the one hand, and the sum of all ambulatory services for CHC subscribers weighted by their fees on the other, may be much more illuminating than an analysis that concentrates, as this one has, primarily on hospital care.[4] But that is another study. In short, information such as that derived in this analysis is a necessary part of any overall examination of the cost implications of CHC and PGPs. It may or may not be the most important and, as such, is an insufficient basis from which to condone or condemn the CHC concept for Canada.

A SHORT SUMMARY

This project set out to quantify in dollar terms the reductions in hospital utilization reported by prepaid group practices and community health centres in the United States and Canada. Along the way the literature that has reported that evidence was reviewed in detail and a behavioural analysis was undertaken to assess the validity of extrapolating those results.

The conversion of utilization evidence to estimates of cost savings involved the articulation, estimation, and application of a behavioural hospital cost

4 McPhee (1973) took a slightly different approach, in comparing actual payments to CHCs with the sum of sources of cost savings.

model. Cost equations explaining variation across hospitals in average inpatient cost per separation and per day were estimated, using data from 182 Ontario public general hospitals for the period 1969-74.

These estimated cost equations were then used as a simulation model in Chapter 5 to produce diagnosis-specific marginal costs per separation and per day for 237 diagnostic categories. The method entailed changing the case load of one diagnostic category and one hospital at a time, working through the implications for average costs to derive marginal costs, and then aggregating first across hospitals and then over time. The ordinal ranking of case costs in general seemed reasonable, and the results suggested marginal costs that were approximately 75 per cent of average costs.

These marginal costs were forced through varying degrees of aggregation in Chapter 6, where they were combined with diagnostically disaggregated hospital utilization data from a small segment of the CHC/PGP literature. The results were summarized earlier in this chapter. The estimating potential savings in hospital and health-care costs was fraught with data problems, it did not produce a consensus as to the likely magnitude of such savings, and it was dependent on a number of assumptions where information was not available. But whereas the hospital utilization studies showed that CHC/PGP members use at least 20 per cent less hospitalization, the potential net expenditure savings, under a variety of generous assumptions, appear to be no more than 5 per cent of total health care expenditures, or 8 per cent of hospital expenditures.

SOME FINAL THOUGHTS AND QUALIFICATIONS

Perhaps the most obvious conclusion one could draw from the past two chapters is not so much a conclusion as the restatement of a common malady. The lack of consistent, mergeable data sets has, as with so much economic (and particularly health-related economic) research, made the analytics excessively cumbersome. Establishing diagnostic equivalents where no such equivalents exist or were meant to exist is at best a hazardous occupation, particularly for a non-clinician. For this particular study much of our diagnostic detail was wasted except for linkage with the Saskatchewan utilization data, which had problems of their own. To make full use of the relative marginal costs would require equally disaggregated utilization data.

On a more positive note, the analysis does provide some insight into the relative costliness of hospital treatment by diagnosis and into the potential of alternative primary care facilities to reduce hospital expenditures through reduced admissions or length of stay. The reader may be troubled by our application of Ontario hospital diagnostic costs to, for example, New York

discharge or admission statistics. But our interest here is in the likely results of establishing community health centres (or similar clinic settings) in Ontario. Thus, the results represent expenditure differentials on hospital care if the Ontario population had the same need for hospitalization as the groups from which utilization data were drawn. This is not to suggest, of course, that further research comparing case complexities and case mixes for various other Canadian and American jurisdictions would not be both timely and interesting. But lack of such data does not seriously compromise these results for the question addressed in this study.

A number of qualifications ought also to be mentioned. The results of this analysis are only as reliable as the principal diagnoses recorded on the separation forms and saved on the tapes that were used to derive case complexities. There are, it seems inevitably, problems of time, cost, and reconciliation in working with data sets of this size. In some instances, for example, total separation figures for a given hospital reported in HS–1 and HS–2 returns did not coincide with the sum of discharges recorded on that hospital's discharge tapes. Tracking down the source of such discrepancies takes time and is rarely cost-effective given the stages of aggregation the discharge data went through in this analysis. It was noted earlier that full use was not made of the wealth of detail embodied in the 237-element marginal cost vectors. It is a sobering experience to take those data and apply them to thirteen categories as in the case of the Sault Ste Marie study. But the results of that linkage were quite consistent with those derived from linking the marginal costs with 188 categories from the Saskatchewan data. And there are many other uses for the type of information generated in the analysis of Chapters 3, 4 and 5.

One of the methodological complaints heard most often in the health economics literature is lack of a representative measure of output for the hospital sector. Days stay or cases have well known maladies but continue to be used with varying degrees of standardization. Marginal costs of the type derived in this study provide the scope for weighting such output proxies when diagnosis-specific case mix information is available. By weighting cases or days with their relative costs, one could compute output measures that would explicitly take into account the fact that all hospitals do not treat similar case mixes and that cases are not all alike in any particular hospital. This would appear to offer a significant improvement over the crude rates and is consistent with Feldstein's (1967) earlier efforts in that direction. The cost analysis itself provides a means for identifying aberrant hospitals – those with large residuals. Such residuals might arise from mis-specification of the cost equations or from the existence in a particular hospital of causal factors not captured within the explanatory variables and not appropriate within the model. If one is satisfied that the

underlying model is reasonable, the estimated equations can be used to identify hospitals whose costs are affected by factors of the second type. An audit process in which such factors are pinned down could then be implemented.

Finally, two recent pieces of literature could conceivably have been improved or expanded through the use of case costs as derived in this study. Denton and Spencer (1975) use hospital days stay in their calculation of age-specific per capita hospital costs. Clearly, using diagnosis-specific cost figures as weights for those hospital days would represent a methodological improvement. The diagnostic breakdown used here to derive case complexities is adaptable to any desired degree of age-sex diagnostic specificity, subject to small sample problems noted earlier. Thus, it would be possible to compute case costs on an age- and sex-specific basis. Manga (1978) was prevented from extending his analysis of the Ontario population's use of medical care to hospitals because of a lack of measures to be applied to that population's hospital utilization. The marginal costs derived in this study are now being applied to that extension (Barer and Manga 1978). But perhaps the most sorely needed extension to this study would be the application of the marginal cost estimates to utilization data from PGPs with large enough enrolment to provide diagnosis-specific data that would fully use the wealth of information in those estimates.

For advocates of CHCs, and this author includes himself among them, the results of this study will undoubtedly induce a little hand-wringing. The effect on expenditures of CHCs seems potentially 'underwhelming.' The results suggest that caution should be exercised by those advocating further widespread changes in practice mode from private to CHC, particularly in the current Ontario situation. This is not to say that savings would be negligible, since 5 per cent of a large number is itself a large number; nor do we wish to imply that a reduction in unnecessary hospitalization is undesirable. Furthermore, there may be other sources of cost-cutting for CHCs, but those must be identified clearly through future research and experiment before the basis for advocating CHCs on a broader scale can become primarily financial. If the opportunity to reduce excess and possibly harmful hospitalization is inherent in the financing and organization of generic PGPs/CHCs, and if such a reduction is the main goal of governments, then by all means let us proceed. But if the reduction in hospital use is a 'derived desire' motivated primarily by budgetary constraints and emotional claims of runaway health care costs, then the evidence here suggests that the reduction in expenditures through this particular policy may be little more than political whimsy in the long run. Certainly problems such as roster-definition must be resolved before anyone should expect much effect from additional CHCs in Ontario. One could envision a situation in which all physicians were practising in CHCs at salaries below their present average incomes,

and it is quite likely that there would be net savings in health care costs. But the success of any health care policy is at least partially dependent on the endorsement of, or at least the lack of overt opposition from, the medical profession. Offering all doctors $35,000 a year and putting them in CHCs is not likely to endear those responsible for policy in this province to the doctors or to promote high-quality care. But it will save money!

APPENDIX A

Construction of variables

This appendix contains a detailed description of the construction of the variables in Table 5 (Chapter 3). Data sources are described in the text of Chapter 3. The dependent variables, CASEX, CASEXD, DAYEX, and DAYEXD are considered first, followed by all independent variables used in the estimation process described in Chapter 4.

CASEX, CASEXD

CASEX is formally defined as inpatient cost per hospital separation. Its formation is dependent on an estimate of total expenditure on inpatient care, which is then divided by total separations for the particular year and hospital. The following description of that estimation process borrows heavily from Barer and Evans (1980).

Recall that our measures of output dictate an interest only in inpatient activities, so that total expenditure figures tend to be misleading (upward-biased) for a hospital in which activities other than inpatient care take place. Particularly susceptible will be teaching hospitals, hospitals with emergency or outpatient departments, and hospitals in which any significant amount of research is done. Variation across hospitals in depreciation, interest payments, and related non-departmental expenses further complicates the issue. Construction costs themselves pose no problem, since they are not recorded as part of operating (or total hospital) expenditures in our data, and we do not wish to include them. There is no reason to suppose that they will affect inpatient cost per case. The hospitals being considered are not-for-profit enterprises; they receive funds for replacement of equipment, construction, and renovation from a third party, and thus feel no obligation (i.e. to shareholders) to try to recapture capital costs by cutting costs elsewhere or raising their 'prices.' For that reason

we can assume that capital expenditures will have no effect on operating expenditures and will therefore not influence per-unit inpatient costs. The intent, then, is to estimate a numerator for the dependent variable that will represent the same mix of activities for each unit of observation (i.e. for each hospital), the mix being composed of the goods and services used for inpatient care only.

The HS-2 form on which each hospital reports its annual expenditures permits a subdivision of total operating expenditures (TOTEX) into four parts: gross salaries and wages (GSW), medical and surgical supplies and other supplies and expenses (MSSOE),[1] drugs, and food. Each department's expenses are similarly divided so that one could, for example, determine for any hospital the expenses on GSW for the laboratory in 1971. To estimate the inpatient expense for each department and expense category, it was necessary to derive a set of algorithms for calculating the non-inpatient care share of total expenditure in each cell of this two-dimensional matrix (departments x expense categories). For example, the GSW component of laboratory expenses could not be wholly allocated to inpatient care, since those facilities are to be shared by admitted and ambulatory patients. In such cases the non-inpatient share of wages and salaries was estimated on a pro rata basis using the inpatient/non-inpatient distribution of department utilization.[2] Certain departments were deemed to be exclusively concerned with non-inpatient care: education and research, ambulance service, and organized outpatient and emergency departments. The radiology, electrocardiography, electroencephalography, and nuclear medicine departments required prorated allocations of each pertinent expense category similar to that for the laboratory.

Once the non-inpatient share of expenses in each expense category and department was deleted from the 'cell' total, the remaining figure was an estimate of inpatient expense plus administrative costs. The method of estimating the share of administrative costs allocable to inpatient care is illustrated again for the GSW category. By aggregating the inpatient and administration GSW figures across departments, we derived an estimate of total inpatient wages and salaries plus all administrative wages and salaries (IPADSW). The administrative component was so defined as to incorporate the share of diagnostic

1 Included in the 'other' category are such items as employee benefits, laundry, linen and housekeeping, plant maintenance, and depreciation.

2 Again using the laboratory as an example, the ratio of non-inpatient laboratory units processed by the hospital to total laboratory units processed by the hospital was applied to GSW for the laboratory. Total non-inpatient laboratory units was defined as the sum of laboratory units processed for outpatients and for patients of other facilities that referred their laboratory work to that particular hospital.

radiology and laboratory services for which the beneficiaries were hospital staff. In effect, the patient determined the allocation of the wage costs of care: services to staff were charged to administration, and the remaining services in those two departments were allocated between inpatient and ambulatory cost categories. Administrative wages and salaries (ADMSW), as defined here, were subtracted from IPADSW to yield IPSW1. The inpatient share of ADMSW was then added according to the following formula to yield IPSW – total inpatient wages and salaries:

$$\text{IPSW} = \text{IPSW1} + [\text{IPTOT}/(\text{TOTEX-ADMIN})] \cdot \text{ADMSW},$$

where ADMIN is total costs of administration and IPTOT is total inpatient costs of all four expense categories excluding the administrative cost categories.[3] A similar procedure was followed for MSSOE.[4]

The result of this process was an estimate of total inpatient operating expenditure (IPEXP), and CASEX follows as CASEX = IPEXP/SEPNS, where SEPNS is total separations from a hospital during the year in question and is recorded on the HS-1 tapes.

Since the estimation of this model is done on a cross-section of 182 hospitals over six years, some adjustment for price variation over time is necessary. This adjustment, like the adjustments for activity and case mix, may take the form of right-side standardization or left-side deflation. Barer and Evans (1980) describe the problems and implicit consequences of each method, and the method described in that paper for constructing a deflator for the hospital sector is adopted here. A summary of the pertinent sections from Barer and Evans (1980) is found in Appendix C. Briefly, the deflator is the reciprocal of a Paasche index and is constructed using input price indices for the four components of hospital

3 As Barer and Evans (1980) point out, an alternative to using the ratio of total inpatient costs (other than administration) to total costs (other than administration) for allocating ADMSW is to apply IPSW_1/ GSW-ADMSW). This ratio represents the share of non-administrative salaries and wages 'consumed' by inpatient care, whereas the allocation of ADMSW by the method adopted here depends on the share of total hospital non-administrative operating costs that inpatient care commands. The assumption implicit in this choice is that the administration input distribution is more likely to be determined by the relative expenditure shares of alternative hospital activities. It might also be noted that IPTOT is the sum of IPSW_1 and the comparable variables for the other three expense categories. The computation of those variables must, then, operationally precede the derivation of IPSW.

4 Food was treated as being solely for the use of inpatients and was not subjected to any such allocation, and inpatient drug expenses were estimated by eliminating from total drug expenditure all drug costs from the emergency, ambulance, special research, and outpatient departments as well as any other ambulatory clinics. In effect, then, the allocation process was necessary only for the GSW and MSSOE categories.

expenditure described above: gross salaries and wages, medical and surgical supplies and other expenses, drugs, and food, each weighted by its relative share of total hospital expenditures. CASEXD is then inpatient cost per case expressed in 1969 dollars: this is one of the two endogenous variables in the time-series/cross-section estimation described in Chapter 4. All marginal cost estimates emerging in later chapters are also expressed in 1969 dollars.

DAYEX, DAYEXD

These variables are the per-day counterparts of the CASEX variables. DAYEX is defined as inpatient cost per hospital day.[5] Inpatient costs are estimated as described above, and total days stay (DAYS), obtained from the HS-1 returns, is defined as patient days for adults, children, and newborns. DAYEXD is derived like CASEXD.

B/C, B^2/C

The B/C variable, the inverse of Evans and Walker's (1972) case flow rate variable (CFR), is straightforward. The number of beds B was taken from the HS-1 tapes, as rated bed capacity on 31 December of each year. Total cases C is identical to separations SEPNS. Squaring a hospital's rated bed capacity leads to construction of the B^2/C variable.

B/D, B^2/D

Again, these are the per-day equivalents of the immediately preceding variables and are constructed in exactly the same way with DAYS substituted for SEPNS.

EDRAT, DEPRAT, OUTXPR

These variables are grouped together because of the similarity in their construction and purpose. Each is a measure of the proportion of TOTEX (total operating expenditures) allocated to its particular function. Their inclusion in the model, discussed in Chapter 3, is intended as a test of the indirect effect of each of the three expenditure categories on inpatient unit costs, where inpatient costs have been purged of these three items.

5 There is a difference between total days stay (DAYS), which is used in the construction of DAYEX, and separated days stay (SDS), which is the sum of the lengths of stay for all cases separated from the hospital in a given year, and which is used to compute ALS. Only coincidentally will DAYS and SDS be identical, but they are usually close estimates of each other.

EDRAT then is defined as total education expenditure divided by TOTEX. Included in the numerator are all expenses from both nursing and medical education departments.

DEPRAT is the non-departmental share of TOTEX, by which is meant that share of expenses not obviously allocable to a standard hospital department. Its numerator is composed of interest on loans, depreciation on land improvement and buildings, service equipment and major equipment, and rental expenses.

OUTXPR, the outpatient share of TOTEX, represents the segment of the hospital operation that is devoted to the treatment of ambulatory patients. The numerator consists of total expenditures for the organized outpatient and emergency departments; ambulance service and special clinics; the outpatient share of salaries and wages for the laboratory, ECG, EEG, nuclear medicine, and radiology departments; and medical, surgical, and drug supplies for the strictly outpatient departments.

F_1 TO F_8

Differences across hospitals in the age and sex composition of inpatients could cause unit costs to vary. But it is not clear to what extent this variation will be captured indirectly by case complexity and average length of stay variables and whether there is an independent direct link. The inclusion of the age-sex factor scores allows that question to be addressed.

The first stage in constructing age-sex standardization variables was to subdivide the inpatient separations into an age-sex grid based on age at date of admission. This matrix contained forty-four columns (one row per hospital) representing 5-year age groupings for each sex. The oldest group were 95+ years, and at the other end of the chronological scale there were separate columns for newborns, under one month, and one month to four years, again for each sex.

The resulting age-sex matrices (one per year) were standardized by converting the elements of each row (hospital) into hospital-specific case-load proportions. Thus, A_{ij} ($i = 1 \ldots 182$ hospitals, $j = \ldots 44$ age-sex categories), the number of discharges in hospital i of age-sex category j was converted to N_{ij}.

$$N_{ij} = A_{ij} \Big/ \sum_{j=1}^{44} A_{ij} \, ; \quad \sum_{j=1}^{44} N_{ij} = 1 \text{ for every } i.$$

A factor analysis of the forty-four standardized case proportion vectors was then used to derive age-sex factor scores. Factors were derived by the principal-components method and then rotated using the varimax procedure, and the

factor scores were computed through regression analysis.[6] These factor scores, which in effect represent the value of each factor for each hospital, were then used as independent variables in the cost analysis.

In this particular application eight factors were found to constitute just over 80 per cent of the accumulated variance of the age-sex proportions. For that reason, eight factor scores were used in the estimations. The calculation of factor scores drew on the Statistical Package for Social Sciences (SPSS) (Nie et al. 1975).

An interpretation of the coefficients on the factor scores (which are reported in Chapter 4) is impossible unless one has some information about the loadings of the original standardized variables on the eight retained factors. That information may be obtained from the rotated factor matrix. This matrix forms part of the output from the SPSS program. The matrices for each year are not reproduced here, but the pertinent data may be obtained from the author. For each original variable, the square of any value in the rotated factor matrix row designated to that variable represents the share of its variance captured by that column's factor. Thus, for 1974, the entry in the rotated matrix in the variable 1 row and factor 2 column was 0.865. Variable 1 was the proportion of case load composed of males aged one month to four years. Then 75 per cent of the variance in that proportion across hospitals is captured by factor 2. We can say then that factor 2 represents the proportion of males in that group. It turned out that the factor 2 column showed similarly high values for age-sex variables representative of males and females under the age of fifteen. This pattern was maintained for all six years of the analysis. Similarly, factor 1 seems to have loaded primarily on those age-sex categories representing the elderly (75+ years) of both sexes. Factor 5 represents women aged 45-64. The other factors either did not load strongly on any particular set of variables or did not load consistently on the same set of age-sex categories. For example, factor 3 represented men aged 50-74 in 1969, 1970, 1972, and 1973, but in 1971 and 1974 it showed higher values for the 20-49 male age group. Factor 4 seems to have complemented this pattern, representing men aged 20-44 in all years but 1971 and 1974,

6 An excellent description of factor analysis is presented by Harman (1967). See, in particular, his explanation of principal components analysis (136-7), the varimax method of factor solution (304-13), and the estimation method of computing factor scores (348-50). Also, see Nie et al. (1975, 482-5) for an interpretation of orthogonal factor rotation and a discussion of the varimax procedure, and Anderson (1958, 272-9) for a concise treatment of the correspondence between principal components and the eigenvectors for the covariance matrix based on the N_{ij} matrix. The corresponding eigenvalues represent the variance of each component, the eigenvalues decreasing in value with each successive component. This information can be used to determine the share of total age-sex variance captured by alternative numbers of factors.

when it took over for factor 3 on the 50-74 male age group. Factors 6 to 8 did not establish any strong or consistent patterns, but they were retained so as to ensure that 80 per cent of the variance in the age-sex proportions was incorporated into the model.

WAGE, SERV

These variables were intended to capture the relative cost of the mix of labour inputs across hospitals. Hospital support personnel (non-medical staff) were divided into eight categories: 1) nursing administration, 2) short-term and long-term units for adults and children, 3) other nursing care, 4) library administration, 5) general administration, 6) laboratory, 7) diagnostic and therapeutic radiology, and 8) other special services. Data pertaining to total hours of work for each sector and the total wage bill allocated to each sector were obtained from the HS-1 and HS-2 tapes. The following notation is used in the construction of these two variables: W_{ij} is the average wage in sector i ($i = 1, \ldots, 8$, above) and hospital j ($j = 1, \ldots, 182$); H_{ij} is the number of labour hours in sector i, hospital j.[7] This basic notation gives rise to the following derivative variables:

$$B_j = \sum_i W_{ij}H_{ij} \quad = \quad \text{hospital } j \text{ wage bill}$$
$$B_i = \sum_j W_{ij}H_{ij} \quad = \quad \text{total provincial sector } i \text{ wage bill}$$
$$H_j = \sum_i H_{ij} \quad = \quad \text{total hospital } j \text{ hours}$$
$$H_i = \sum_j H_{ij} \quad = \quad \text{total provincial sector } i \text{ hours}$$
$$H = \sum_i \sum_j H_{ij} \quad = \quad \text{total provincial hours}$$
$$W_i = B_i / H_i \quad = \quad \text{provincial average sector } i \text{ wage rate}$$
$$W_j = B_j / H_j \quad = \quad \text{average wage rate, hospital } j$$
$$\overline{H}_i = H_i / H \quad = \quad \text{sector } i \text{ proportion of total provincial hours}$$
$$\mathrm{PTH}_{ij} = H_{ij} / H_j \quad = \quad \text{sector } i \text{ proportion of total hospital } j \text{ hours.}$$

Obviously, one could use W_j as a wage level indicator for each hospital and include it as an independent variable in the average cost equation. Ideally however we would like to obtain additional information from the available data.

7 No explicit account is taken of possible skill differences across hours within a sector. Although the service data contained in the HS-1 returns give a breakdown by department of paid hours for various personnel classifications (graduate nurses, orderlies, etc.), the financial data from the HS-2 returns do not do so, and any finer disaggregation of sectors into personnel categories is therefore not possible using this data source.

In particular it would be useful to differentiate the wage level and service mix effects that jointly determine hospital variation in W_j. This was achieved by constructing two variables:
- SERV: an indicator of the relative cost of a hospital's personnel (service) mix. A value greater than 1 means that the hospital in question employs personnel in a more costly combination than the provincial average (i.e. that the hospital employs more 'high wage' personnel than average).
- WAGE: an indicator of the extent to which hospital j is a relatively high-wage hospital.

If hospital j has a relatively expensive personnel mix as defined here, we would expect that the wage bill for that hospital would be greater than a hypothetical wage bill constructed by using hospital j wage rates but provincial personnel-mix proportions. Thus,

$$\text{SERV}_j = B_j / H_j \sum_i W_{ij}\bar{H}_i = W_j / \sum_i W_{ij}\bar{H}_i .$$

This measure will be upward-biased for any hospital having one or more sectors in which it employs no one, because the denominator is constructed from provincial skill proportions but individual hospital sector wage rates. To correct this, $\bar{H}_i$ was computed as

$$\bar{H}_i = H_i / \left(\sum_i H_i \cdot \text{IND}_i\right)$$

where $\text{IND}_i = 1$ if $W_{ij} \neq 0$, and $\text{IND}_i = 0$ if $W_{ij} = 0$.

Thus, if $W_{ij} = 0$, the i^{th} sector hours were excluded in computing provincial proportions.

If hospital j pays relatively high wages, this would show up in a measure using as numerator hospital j's wage bill and as denominator the provincial personnel category wage levels weighted by hospital j's personnel mix. Thus,

$$\text{WAGE}_j = B_j / \sum_i W_i H_{ij} = W_j / \sum_i W_i PTH_{ij}$$

In this case, there are no zero-value complications because provincial wage levels are used in the denominator.

ALS

The average length of stay variable needs little explanation. The HS-1 returns report total hospital days of all separations from a hospital in a given year (SDS). This was divided by total inpatient separations to derive ALS = SDS/SEPNS.

OCC[8]

A hospital's occupancy rate is formally defined as the ratio of patient days (DAYS) to total available bed days.[9] Thus,

$$\text{OCC} = \text{DAYS}/(365 \times B).$$

CMPXC1, CMPADJ

The development of CMPXC1 is based on Theil (1967, 1971) and Evans and Walker (1972). This description is taken to a large extent from Barer (1977) and Barer and Manga (1978).[10]

The discussion in Chapter 3 of methods of case-mix standardization pointed out that the number of distinct variables necessary for that standardization could be minimized by constructing a hospital complexity measure that was a weighted average of case complexities. (See Barer (1981) for a review of methods of standardizing, and Klastorin and Watts (1980) for a discussion of the implicit assumptions in this type of construction.) The CMPXC1 variable is exactly that: a weighted sum of the (standardized) complexities of cases treated in the hospital, the weights being the proportions of total hospital case load contained in each diagnostic category. The method of devising the case complexities is an application of information theory.

The data on which both the case and hospital complexities are based were obtained from hospital discharge forms. Included on those forms is information about the hospital from which each patient was discharged and the principal diagnosis. This source of data makes available the distribution of separations by hospital and by diagnosis. The main premise underlying the information theory

8 While this variable does not appear in either equation (5) or (6) of the model specified in Chapter 3, it is used at later stages of the analysis for reasons outlined in Chapter 4.

9 Occupancy rate is not, as Evans and Walker (1972) suggest, linked exactly to CFR (C/B) and ALS by the relationship of CFR = (3.65 x OCC)/ ALS, since OCC is a function of DAYS while ALS is a function of SDS. Only if DAYS = SDS will that relationship hold, although it is a useful and usually close approximation.

10 Other references describing the use of information theory in the context of hospital complexity/specialization measures are Walker (1976), Horn and Schumacher (1979), and Schumacher et al. (1979).

complexity construct is that the more even the distribution of a particular case type across provincial hospitals, the lower its complexity. At the extreme, a diagnostic category with cases treated in only one hospital would be posited to be very complex.

Consider an event, say the admission of a particular patient to a hospital, to which we are able to assign a prior expectation or probability p. For example, if a patient requires hospitalization but no further information is available other than the number of hospitals (N) in the province, our best guess might be that that patient has a $1/N$ chance of entering hospital i, so that $p=1/N$. Suppose now that we are told that the patient has entered a particular hospital. What is the information gain implicit in that message? The magnitude of that gain will obviously depend on the prior value of p. If there had been only one hospital in the province, there would be no increase in our information after the patient was admitted. The larger the set of hospitals, the greater the information gain will be. So if p is initially close to 1 for a given patient and hospital, and the patient ultimately enters that hospital, the marginal change in information is small. It follows that to measure the information received from a message in terms of the original probability p of an event occurring we would need a decreasing function of p (Theil 1971). The logarithm of the reciprocal of the probability is commonly used because of its additivity for independent events (Theil 1967, 4). Following Theil (1967, 1971) and Evans and Walker (1972), we let h, the 'information gain' function, take the everywhere-decreasing, additive form:

$$h(p) = ln\left(\frac{1}{p}\right).$$ [11]

Given the prior probability p, the expected information gain is straightforward:

$$\begin{aligned} EG &= p \cdot h(p) + (1-p) \cdot h(1-p) \\ &= p \cdot ln(1/p) + (1-p) \cdot ln(1/(1-p)), \end{aligned}$$

where $(1-p)$ refers, of course, to the probability of the complementary event occurring.

11 The property of additivity is illustrated simply for two independent events with probabilities p_1 and p_2. The information content of a message indicating that both events have occurred would be

$$\begin{aligned} h(p_1, p_2) = ln[1/(p_1 \cdot p_2)] &= -ln(p_1 \cdot p_2) \\ &= -[ln(p_1) + ln(p_2)] \\ &= ln\frac{1}{p_1} + ln\frac{1}{p_2} \end{aligned}$$

If this framework is extended to the more general case of N mutually exclusive events, one of which must occur, so that

$$\sum_{i=1}^{N} p_i = 1,$$

then the expected information embodied in the message indicating occurrence of one of those events is

$$\mathrm{EG} = \sum_{i=1}^{N} p_i h(p_i) = \sum_{i=1}^{N} p_i \, ln(1/p_i).$$

So far the discussion has dealt exclusively with prior probabilities and with messages conveying information on the actual incidence of events. Let us now consider messages of a slightly different nature which transmit information on posterior (or altered) probabilities. Returning to the example of one event with prior probability p, let us assume we receive a message indicating an altered probability of occurrence q for that event. (Obviously the earlier example, in which the event did occur, is just one possibility in this 'message space', where $q = 1$.) What is the information gain from this type of message? If the event we are considering ultimately occurs, the information gain was defined as $ln(1/p)$. We have now received an updated probability q of that event occurring. If the event occurs, the information gain from the actual occurrence message will now be $ln(1/q)$. Therefore the information gained (or lost) through receipt of the intermediate message is represented by the difference in these two values,

$$h(p) - h(q) = ln(1/p) - ln(1/q) = ln(q/p).$$

Note that there is an actual information gain from knowing the revised probability only if a subsequent message conveys further information regarding occurrence of an event. But the expected information content of the message conveying the new probability q is

$$\mathrm{EG} = q \cdot ln(q/p) + (1\text{-}q)\, ln[(1\text{-}q)/p].$$

Extending this to N mutually exclusive events, for which we receive posterior probabilities q_i, gives us

$$\mathrm{EG} = \Sigma q_i \cdot ln(q_i/p_i).$$

Now, in the context of hospital case load distribution we introduce the following notation:

$$p_{ij} = c_{ij} / C_i,$$[12]

where c_{ij} is the number of cases of type j in hospital i, and C_i is the total cases in hospital i. Then the p_{ij} will form the weights to be used in computing hospital complexities by aggregating across case complexities. In addition let

$$q_{ij} = c_{ij} / C_j,$$

where C_j is the total cases of type j in the province; and

$$Q_j = C_j / C,$$

where C is the total provincial hospital separations in a given year. One of the N hospitals in Ontario must discharge each case. Then the N mutually exclusive events are simply the possibilities of a particular case being a separation from each of the N hospitals (assuming, of course, that we do not know where the patient lives, the disease, or the admitting hospital).

If the prior probability of a case of type j being a separation from the ith hospital is assumed to be $1/N$, i.e. if there is no reason to favour one hospital over another (the only available information being the number of hospitals), and if the posterior probability is based on the q_{ij}'s, the actual distribution of case type j discharges across Ontario hospitals, then the expected information gain from calculating the q_{ij}'s is

$$EG_j = \sum_i q_{ij} \ln(Nq_{ij}).$$

But how does all this relate to case complexity? The linkage is based on the assumed correlation between the magnitude of an information gain and the complexity of a particular type of case. First 'we hypothesize that complex cases tend to be handled in a few hospitals with more extensive facilities and more specialized staff, while relatively straightforward cases tend to be distributed more evenly over the hospital system.'[13] We have seen that the magnitude of any

12 This p_{ij} should not be confused with the p and p_i notation used in the immediately preceding discussion. They are not related in any way. A similar caveat applies to q_{ij} in the following discussion.

13 Evans and Walker (1972, 399). See also their footnote 4 on that page for an alternative hypothesis that suggests that the process of admission may be likened to a queuing process in which cases are admitted in order of severity and place in the queue. By that hypothesis hospitals with fewer beds would be expected to handle the most complex cases first, and the

information gained from new feedback depends on the magnitude of deviation from the expected message. As an extreme example, if we expect $1/N$ cases of type j to be treated in each hospital, but find later that only one hospital in the province treats this kind of case ($q_{ij} = 0$ for every hospital except one), the expected information gain from that new information is relatively large. The value of EG_j for that case type will be relatively high, which is synonymous with what we regard as a complex diagnostic category. Thus we postulate a direct relationship between the hypothesized complexity concept and the probability distributions based on the q_{ij} and $1/N$. The larger the expected information gain (or equivalently the more concentrated the posterior case distribution), the more complex we believe the diagnostic category to be. The M vectors (for the M diagnostic categories) representing the distribution of each category across provincial hospitals are reduced in this manner to a scalar denoted by EG_j, for the jth diagnostic category and prior probabilities $1/N$.

The derivation of CMPXC1 for each hospital requires two further steps. So as to have average case complexity equal to 1.0, we standardize the EG_j's by setting

$$\bar{H}_j = \mathrm{EG}_j \Big/ \sum_j \mathrm{EG}_j Q_j.$$

It follows from the previous discussion that CMPXC1 for the ith hospital is then

$$\mathrm{CMPXC1}_i = \sum_j \bar{H}_j \cdot p_{ij}.$$

It was noted earlier that a variable number of hospitals, ranging from 209 in 1971 and 1973, to 212 in 1969 and 1972, formed the data base for computing the case complexities. These samples are larger than the set of 182 hospitals retained for the cost analysis because the conceptual basis of the case complexity development requires use of the distribution of separations across all acute-care public general hospitals in the province in any year. *Hospital* complexities were calculated only for the 182 hospitals.

Primary diagnosis is recorded on the 106-D discharge forms according to the Ontario Broad Code (OBC) classification. This classification aggregates the ICDA–8 into 260 categories. Appendix D lists the broad codes and the ICDA–8 codes represented in each category. Using the discharge tapes, a 'C matrix'

less complex would remain backlogged. The result would be a more even provincial distribution of complex cases, which would yield, by our methodology, low case complexities. Evans and Walker's empirical results tend to refute this alternative hypothesis, as do our case complexities, since those cases that one might expect to have relatively high complexity ratings do in fact bear out those expectations in most instances (Appendix D).

consisting of c_{ij} entries (cases of type j in hospital i) was compiled for each year. In 1973, for example, the dimension of the C matrix was 209 by 260, and the entry in the (i,j) cell indicated total cases of OBC type j discharged from hospital i. Because of the construction of $\bar{H}_j$ the measure becomes unreliable if C_j is very small.[14] Twenty-three OBC categories did not have enough cases in one or more years, necessitating an aggregation up to 237 categories. The categories so aggregated, and the OBCs with which they were grouped, are listed in Table D.1.

The computation of case complexities just described was applied to this adjusted C matrix, resulting in a vector of $\bar{H}_j$ values. (The six-year means for each of the 237 diagnostic categories are also reported in Appendix D.) By inserting these values in the CMPXC1 equation above, hospital complexities were computed.

For time series analysis, however, it is not enough to use the CMPXC1 variable directly in the estimation procedure; to do so will lead to biased estimates of the effect of CMPXC1 variance on variance in CASEXD and DAYEXD. Recall that the case complexities ($\bar{H}_j$) were standardized to impose a mean value of 1.0 in each year. But there may be a shift over time in provincial case-mix proportions. Such a shift ought to be incorporated in hospital complexities yet would not be because of the yearly EG_j standardization. We would like the hospital complexity measures to capture not only case-mix dispersion within a given year but also shifts over time in provincial case mix. To incorporate this temporal effect, an adjusted case complexity variable CMPADJ was constructed from a base year vector of $\bar{H}_j$'s.

The choice of a base year for the case complexities proved to be inconsequential because these measures scarcely varied with time. The stability of the $\bar{H}_j$ values is illustrated in Table A.1, which reports correlations of the case complexity vectors over time. It is clear that the relative complexity of diagnostic categories was virtually unchanged over the six-year period. It was not surprising then that the values of an aggregated yearly provincial complexity measure, defined as $\Sigma_j C_j \bar{H}_j / C$, did not vary substantially with choice of base year. The effect of adopting two alternative years' $\bar{H}_j$ values is illustrated in Table A.2.

Since the hospital complexity measure for a given year depends directly on the dispersion of cases (and thus on case complexities) in that year, a comparison of CMPXC1 values over time, for a given hospital, will understate that hospital's

14 The details are not central to the argument here, but they relate to the link between the construction of EG_j, and the concept of the entropy (Theil 1967, 26). Where $C_j < N$, the maximum entropy in the distribution of cases of type j across N hospitals will be lnC_j, rather than lnN.

TABLE A.1

Correlation of case complexity ($\overline{H}_{jt}$) vectors

t	1969	1970	1971	1972	1973	1974
1969	1.000	0.980	0.948	0.926	0.927	0.930
1970		1.000	0.964	0.939	0.941	0.944
1971			1.000	0.964	0.963	0.959
1972				1.000	0.984	0.976
1973					1.000	0.977
1974						1.000

TABLE A.2

Aggregated yearly case complexities ($\Sigma_j C_{jt}\overline{H}_{jt}/C_t \div \Sigma_j C_{j74}\overline{H}_{jt}/C_{74}$)

	Using 1969 $\overline{H}_j$	Using 1974 $\overline{H}_j$
1969	0.94993	0.94729
1970	0.97223	0.96899
1971	0.98070	0.97928
1972	0.98409	0.98182
1973	0.99809	0.99648
1974	1.0000	1.0000

shift in complexity by an amount shown by the figures in Table A.2. For example, a hospital having a CMPXC1 value of 0.96 in 1969 and the same value in 1970 would appear to be unaltered in its case-mix complexity. However, using constant 1974 $\overline{H}_j$'s would probably have yielded figures in the order of 0.96 and 0.982. Thus, even though the province as a whole tended towards a more complex mix of cases in 1970, as shown in Table A.2, yearly standardization around a mean of 1.0 makes it impossible to include that trend in any hospital's CMPXC1 value. Only a hospital's shift in case mix vis-à-vis the provincial mix for that year (1970) is captured, to the exclusion of changes in the relationship between its proportions and the provincial 1969 proportions. In the example chosen here the fact that the provincial case-mix trend was towards more complex cases could eliminate evidence of a similar trend in any specific hospital.

To account for this effect, the variable used in the econometric analysis described in Chapter 4 and Appendix E of this report is constructed by weighting each hospital CMPXC1 value by the appropriate figure from Table A.2. Thus

$$\text{CMPADJ}_{i69} = \text{CMPXC1}_{i69} \cdot 0.94729$$

for the ith hospital.

The correlation of CMPXC1 vectors over time was quite high; the 1969 with 1974 correlation of 0.864 was the lowest.

Two alternative hospital complexity variables were constructed and tested. Each was found to be inferior to CMPXC1 as an explanatory variable in equations (5) and (6) of Chapter 3. Details of their construction are given in Appendix B.

SPCLC1

In a manner similar to that described for CMPXC1, the expected information concept may be used to develop a measure of the specialization of a hospital. By specialization is meant the degree to which a hospital concentrates on a relatively small share of the 237 OBCs during a given period. If we assume that small hospitals cannot usually handle as many different kinds of cases as large hospitals, we can hypothesize that smaller hospitals will, in general, be 'more specialized' than their larger counterparts. Of course this does not imply that large hospitals cannot be highly specialized. In fact, the other instance where we would expect to find high specialization would be in hospitals that have been established deliberately to treat a few specified illnesses. This matter receives more attention in Chapter 4.

In this instance we are interested in the diagnosis of a given discharge. The prior probability of any particular hospital separation being of diagnostic category j is assumed to be Q_j, the provincial share of total discharges that are of type j. If we now get access to additional information – the hospital from which the patient was discharged – the posterior probability of that discharge being of type j is p_{ij}. The expected information gain from learning the new probabilities, the p_{ij}, or equivalently from learning the deviation of each hospital from the provincial case distribution is represented by

$$G_i = \sum_j p_{ij} \cdot ln(p_{ij} / Q_j).$$

Thus, the greater the deviation of a hospital's case-mix proportions from the provincial proportions, the larger the expected information gain and the greater the value of the hospital's SPCLC1 measure. As with the complexity measures, this variable is standardized so that

$$\text{SPCLC1}_i = G_i / \sum_i G_i P_i ,$$

where $P_i = C_i / C$, hospital i's proportion of total provincial separations.

As with the complexity variable, two alternative measures of hospital specialization were constructed and tested. They, too, are described in Appendix B. The SPCLC1 variable proved superior to either alternative.

APPENDIX B

Alternative measures of hospital complexity and specialization

An alternative hospital complexity construction also based in information theory was used by Evans and Walker (1972). It is similar to CMPXC1 in all respects, with the exception of the prior probability. The $p = 1/N$ used in the CMPXC1 variable was based on the premise that our only prior information was the number of hospitals in the province. Let us instead assume a little extra prior knowledge about the relative size of hospitals, specifically in the form $p_i = P_i$, where $P_i = C_i/C$. Then the prior probability of a given case being discharged from the ith hospital is equal to the share of all patients in the province discharged from the ith hospital. In this case, $\mathrm{EG2}_j = \Sigma q_{ij} \ln(q_{ij}/P_i)$, and the rest of the construction follows as before. This variable was substituted for CMPXC1 in the early stages of the model estimation and was, independently of equation specification, always associated with lower t and $\bar{R}^2$ values. The inter-year correlation of this variable fell as low as 0.733 (1969 with 1974). This variable was dropped in favour of CMPXC1 for the later stages of the estimation process.

A third hospital complexity measure tried in the estimation process was similar to the previous two in that it was formed by aggregating case complexities but different in that those case complexities were based on standard gamble rather than information theory.

In a study for the Ontario government, Wolfson (1974) applied the von Neumann-Morgenstern utility framework to the question of determining relative health state severities. The standard gamble technique was used to determine indifference probabilities for each of 239 broad codes (OBCs). The indifference probabilities for fifty-nine benchmark diseases were determined through physician interviews in which the 'physician-as-patient' was asked what value of p would make him indifferent between the options of continuing to suffer from the given disease or taking a 'certain-cure' pill that would cause instant death (with a probability of p) or instant cure (1-p). The mean values of

TABLE B.1

Correlation of CMPXCW with other hospital complexity measures

Year	CMPXC1	CMPXC2
1969	0.6139	0.8244
1970	0.6700	0.8591
1971	0.6215	0.8040
1972	0.6105	0.7801
1973	0.5461	0.7331
1974	0.4922	0.6378

responses from a (non-random) sample of general practitioners became 'risk weights', ranging from 0 to 1, for each of the fifty-nine benchmark disease states. Risk weights for the other 180 OBC categories were interpolated from those benchmarks.

Since our 237 OBC categories were based on the full 260 classes, comparability of the two methods required the assigning of risk weights to the twenty-one codes excluded from Wolfson's list. They were either mental disorders or trivial or ill-defined conditions that did not readily lend themselves to the indifference probability approach. Thus, OBCs 068-076 inclusive (mental disorders), 255 (plastic surgery), 258 (immature newborn), and 260 (organ transplant donors) were arbitrarily assigned risk weights of 0.0. The remaining nine OBC codes (176, 224, 225, 252-54, 256, 257, and 259) were assigned risk weights of 0.0001 (an approach approved by Alan Wolfson in personal communication. Accordingly we constructed new *C* matrices with twelve fewer columns for this segment of the analysis only. Each hospital's weights (p_{ij}'s) were then based on this reduced total case load.

The hospital complexities (CMPXCW), derived by aggregating across the risk weights using the adjusted p_{ij} as loadings proved to be stable over time (the 1969/1974 correlation was 0.961), but correlations with CMPXC1 ranged from 0.49 to 0.67 over the six years. Perhaps not surprisingly, the CMPXCW variable explained less of the dependent variables' variance than either CMPXC1 or CMPXC2. The case complexities on which CMPXCW was based reflect the relative indesirability of disease states from a patient's perspective rather than relative treatment complexities. As Table B.1 shows, these are not close to being perfectly correlated and one would expect unit cost variance to be a function more of treatment complexity than patient discomfort.

In addition to the SPCLC1 variable, Evans and Walker (1972) used two alternative measures of specialization, each based on a different prior hypothesis. The details will not be repeated here, but briefly SPCLC2 takes as its prior

distribution not the provincial proportions (Q_j) but the proportions of the fictitious 'average hospital' ($\sum_i p_{ij}/N$). The development of SPCLC3 proceeds from a prior distribution of $1/j$, 'beginning from the assumption that there are equal numbers of cases in each diagnostic class' (Evans and Walker 1972, 402).

These two measures were found to add less explanatory power and to be less significant in all cases than SPCLC1.

APPENDIX C

Deflation of CASEX and DAYEX

It was noted in Appendix A that the deflation method adopted to standardize for inter-temporal input price variation was taken from Barer and Evans (1980). Accordingly only the essentials will be reproduced here along with the results for our data set.

The deflator was constructed from input prices and input expenditure shares. Since CASEX for any hospital in year t is defined as inpatient expenditure in that year divided by separations in that year, deflation involved converting CASEX to CASEXD (year t inpatient expenditure valued in base year prices, divided by the same denominator). In other words, the numerator must be converted from $\Sigma P_t Q_t$ to $\Sigma P_0 Q_t$, where **P** and **Q** are price and quantity vectors respectively. This requires the division of CASEX by a Paasche index (Evans 1973, Appendix 1-2).

The input categories adopted were identical to the four categories described in Appendix A in the context of the CASEX and DAYEX variable construction: personnel; medical, surgical and other supplies and expenses; drugs; and food. Recall that the derivation of those variables necessitated the isolation of the inpatient share of costs in each category. The input expenditure shares used in constructing the deflator were then shares of the estimated inpatient expenditure falling within each input class. Table C.1 shows the aggregated (182 hospital) shares for each year. The share of total inpatient costs claimed by wages and salaries was relatively constant during this six-year period. Both drugs and food declined in importance, and MSSOE gained a correspondingly greater expense share. What is particularly evident is the dominant role of wages and salaries in the cost of caring for inpatients. Given the service-intensive nature of this industry, however, these shares are not particularly surprising.

The input price indices also reported in Table C.1 were estimated or derived from a variety of sources. Statistics Canada does not yet report an industry

selling price index for medical and surgical supplies. For that reason we combined that category with other supplies and expenses. The Gross National Expenditure implicit price deflator (see *Canadian Statistical Review* 1970-5) was adopted as a proxy price index for this amalgam of inputs. The product group industry selling-price indices did provide price series for the food (less the alcoholic beverage component) and pharmaceutical input categories.

Again, we relied on the HS-1 and HS-2 forms for the data needed for the construction of a hospital sector wage index. Total paid hours and total wage bill data are subdivided into eight inpatient-related service centres in the HS-1 and HS-2 forms: nursing administration, nursing care in short-term and long-term units for adults and children, other nursing care, medical records and library administration, laboratory, diagnostic radiology, therapeutic radiology, and other special services. If we denote the wage rate and total paid hours respectively for the ith centre by W_{ijt} and H_{ijt} for the jth hospital in year t, then the wage index (WI) is given by

$$\mathrm{WI}_t = \sum_i \sum_j W_{ijt} H_{ijt} \Big/ \sum_i \sum_j W_{ij\bar{t}} H_{ijt} \qquad (\bar{t} = 1969),$$

itself a Paasche index.

Borrowing notation from Barer and Evans (1980), and recalling that we are employing four input categories, we let

P_{it} = price level, category i, year t (i=1, ... ,4);
Q_{it} = quantity, category i, year t;
$E_{it} = P_{it} Q_{it}$ = total inpatient expenditure, category i, year t;
PI_{it} = price index, category i, year t.

Then the inpatient expenditure shares (ES) reported in Table C.1 are simply

$$\mathrm{ES}_{it} = E_{it} \Big/ \sum_{i=1}^{4} E_{it} .$$

Recalling that the Paasche index necessary for deflating current dollar expenditures is given by

$$\mathrm{PAI}_t = \sum_{i=1}^{4} P_{it} Q_{it} \Big/ \sum_{i=1}^{4} P_{i\bar{t}} Q_{it} , \tag{1}$$

and that price levels and price indices are linked by

$$P_{i\bar{t}} = (\mathrm{PI}_{i\bar{t}} / \mathrm{PI}_{it}) \cdot P_{it} , \tag{2}$$

TABLE C.1

Input price indices and aggregated inpatient expenditure shares

	GSW [a]		MSSOE [b]		DRUGS		FOOD	
t	Price index	Expenditure share	Price index	Expenditure share	Price index	Expenditure share	Price index	Expenditure share
1969	100.00	0.721	100.0	0.203	100.0	0.035	100.0	0.041
1970	110.1	0.722	104.1	0.205	100.9	0.035	102.6	0.037
1971	121.2	0.724	107.4	0.209	102.2	0.033	105.1	0.034
1972	131.6	0.721	112.8	0.214	104.4	0.032	113.6	0.033
1973	143.7	0.714	122.1	0.222	105.0	0.031	137.3	0.033
1974	175.6	0.718	139.0	0.224	111.6	0.028	165.1	0.031

a GSW = gross salaries and wages, primarily of non-medical staff personnel.
b MSSOE = medical and surgical supplies plus other supplies and expenses.

TABLE C.2

Paasche index for Ontario hospitals (1969 = 100)

1969	100.0
1970	108.3
1971	116.7
1972	125.4
1973	136.6
1974	162.9

we can rearrange equation (1) as follows,

$$\begin{aligned} \mathrm{PAI}_t &= E_t \,/ \sum_{i=1}^{4} P_{i\bar{t}}\, Q_{it}\,, \text{ where } E_t = \sum_{i=1}^{4} E_{it}, \\ &= E_t \,/ \sum_{i=1}^{4} (\mathrm{PI}_{i\bar{t}} / \mathrm{PI}_{it}) \cdot E_{it} \\ &= 1 \,/ \sum_{i=1}^{4} (\mathrm{PI}_{i\bar{t}} / \mathrm{PI}_{it})\, \mathrm{ES}_{it}\,. \end{aligned} \tag{3}$$

Inserting the ES and PI values from Table C.1 into equation (3) for each year generates the Paasche index series reported in Table C.2. It then follows that $\mathrm{CASEXD}_{it} = \mathrm{CASEX}_{it} / \mathrm{PAI}_t$ and an analogous calculation provides DAYEXD_{it} for the ith hospital.

APPENDIX D

Diagnostic classification for case mix variable construction

The basis for our choice of 237 diagnostic categories was the 260-item Ontario Board Code (OBC). In the description of the construction of the CMPXC1 variable (Appendix A), it was pointed out that if very few cases of a given diagnosis are discharged province-wide, the information theory construction underlying the case complexities breaks down. This type of small-sample problem was encountered in one or more years for 23 of the 260 OBCs. For each of these cases a suitable OBC category with which to aggregate the small sample was chosen in consultations with Eugene Vayda during which reference was made to the underlying ICDA-8 classification.

Table D.1 describes each category thus affected and the OBC with which it was combined. It was obviously impossible to make perfectly legitimate aggregations. The fact that each of the eliminated clodes was an entity in itself suggests that it was different enough from all other categories to warrant its own code. Rather, we attempted to place each such code in the most closely applicable of the remaining categories; applicability was determined both by similarity of aetiology and of required treatment intensity. While this particular aggregation may invite suggestions for more suitable groupings, it should be recalled that in all cases we were dealing with extremely small numbers, so that the choices represented in Table D.1 will not seriously affect the subsequent analysis.

Table D.2 lists the resulting 237 diagnostic categories for which case complexities were computed and on which hospital complexities were based. For each category the mean case complexity ($\bar{H}j$) value (average of $\bar{H}j$ over the six years) is reported.

TABLE D.1

Aggregation of Ontario Broad Codes: 260 → 237

Code eliminated	Description	Combined with	Description
005	Zoonosis	006	Other bacterial diseases
008	Meningococcal infection and tetanus	077	Meningitis and other inflammatory diseases of the central nervous system
010	Poliomyelitis	013	Aseptic meningitis and other enterovirus diseases of the central nervous system
011	Acute poliomyelitis unspecified	013	
023	Malignant neoplasm of small intestine, including duodenum	024	Malignant neoplasm of large intestine except rectum
027	Malignant neoplasm of trachea	029	Malignant neoplasm of other respiratory organs
036	Malignant neoplasm of fallopian tube and broad ligament	034	Malignant neoplasm of uterus
051	Benign neoplasm of male genital organs	053	Other benign neoplasms
061	Nutritional marasmus	062	Avitaminoses and other nutritional deficiency
079	Other hereditary and familial diseases of nervous system	078	Hereditary and familial diseases of the nervous system
174	Renal disease and other toxemias of pregnancy and the puerperium	173	Pre-eclampsia, eclampsia, toxemia-unspecified and hyperemesis gravidarum

TABLE D.1 continued

Code eliminated	Description	Combined with	Description
178	Delivery complicated by bony pelvis	179	Delivery complicated by fetopelvic disproportion
204	Other anomalies of nose	205	Cleft palate
214	Other maternal conditions unrelated to pregnancy	213	Chronic circulatory and genito-urinary diseases in mother
215	Toxemia of pregnancy	173	See above
216	Maternal ante- and intrapartum infection	213	See above
221	Hemorrhagic disease of newborn	219	Hemolytic disease of newborn
223	Termination of pregnancy	175	Abortion
236	Injury with open intracranial wound	235	Intracranial injury without mention of open intracranial wound
237	Intracranial injury – late effects	235	
252	Medical or special examination	256	Special conditions and examinations without sickness
253	Persons receiving prophylactic inoculation and vaccination	256	
259	Mature infant not classified as newborn	256	

TABLE D.2

Adjusted Ontario Broad Codes and case complexities

237–Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
001	001	000-003	Salmonella infections, cholera, and typhoid	1.679
002	002	004-009.0 009.2, 009.9	Other intestinal infections	0.693
003	003	009.1	Diarrhea	0.877
004	004	010-019	Tuberculosis	1.445
005	005, 006	020-027, 030-033, 039	Other bacterial diseases	1.535
006	007	034, 035	Streptococcal sore throat, scarlet fever, and erysipelas	1.297
007	009	038	Septicemia	1.602
008	012	044	Late effects of acute poliomyelitis	1.977
009	010, 011, 013	045, 046, 040-042, 043	Aseptic meningitis and other enterovirus diseases of central nervous system; poliomyelitis	2.068
010	014	050-057	Viral diseases accompanied by exanthem	0.907
011	015	062-066	Viral encephalitis	1.396
012	016	071-079, 060-061, 067-068	Other virus diseases	0.664
013	017	070	Infectious hepatitis	1.004
014	018	090-099	Venereal diseases	1.352
015	019	100-104, 080-089	Other spirochetal diseases	0.966
016	020	110-117, 120-129, 130-136	Mycoses, helminthiases, and other infective and parasitic diseases	0.942
017	021	140-149	Malignant neoplasm of buccal cavity and pharynx	2.248
018	022	151	Malignant neoplasm of stomach	1.042

TABLE D.2 continued

237–Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
019	023, 024	152, 153	Malignant neoplasm of small intestine, including duodenum Malignant neoplasm of large intestine except rectum	0.923
020	025	154	Malignant neoplasm of rectum and rectosigmoid junction	1.100
021	026	150, 155-159	Malignant neoplasm of other digestive organs	1.117
022	028	162.1	Malignant neoplasm of bronchus and lung	1.358
023	027, 029	160-161, 162.0, 163	Malignant neoplasm of trachea Malignant neoplasm of other respiratory organs	2.223
024	030	170	Malignant neoplasm of bone	1.952
025	031	172, 173	Malignant neoplasm of skin	1.587
026	032	174	Malignant neoplasm of breast	1.320
027	033	180	Malignant neoplasm of cervix uteri	2.500
028	034, 036	181, 182, 183.1, 183.9	Malignant neoplasm of uterus, fallopian tube, broad ligament	1.696
029	035	183.0	Malignant neoplasm of ovary	1.923
030	037	184	Malignant neoplasm of other and unspecified female genital organs	2.287
031	038	185	Malignant neoplasm of prostate	1.076
032	039	186, 187	Malignant neoplasm of other and unspecified male genital organs	2.167
033	040	188	Malignant neoplasm of bladder	1.441
034	041	189	Malignant neoplasm of other and unspecified urinary organs	1.610
035	042	191	Malignant neoplasm of brain	2.197

TABLE D.2 continued

237–Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
036	043	171, 190, 192-199	Other primary and secondary malignant neoplasms	1.181
037	044	204-207	Leukemia	1.841
038	045	200-203, 208-209	Other neoplasms lymphatic and hematopoietic tissue	2.252
039	046	217	Benign neoplasm of breast	1.133
040	047	216	Benign neoplasm of skin	1.392
041	048	218-219	Benign neoplasm of uterus	1.005
042	049	220	Benign neoplasm of ovary	0.965
043	050	221	Benign neoplasm of other female genital organs	1.025
044	052	225	Benign neoplasm of brain and other parts of nervous system	1.802
045	051, 053	210-215, 223, 224, 226-228, 222	Benign neoplasm of male genital organs Other benign neoplasms	0.969
046	054	234.0	Carcinoma in situ of cervix uteri	1.349
047	055	230-233, 234.1, 234.9, 235-239	Other neoplasms of unspecified nature	1.217
048	056	242	Thyrotoxicosis with or without goiter	1.633
049	057	240, 241	Nontoxic goiter	1.290
050	058	243-246	Other diseases of thyroid gland	1.172
051	059	250	Diabetes mellitus	0.554
052	060	251-258	Other endocrine diseases	1.465
053	061, 062	268 260-267, 269	Nutritional marasmus, avitaminoses, and other nutritional deficiency	1.028
054	063	270-273	Congenital disorders of metabolism	2.674
055	064	274-279	Other metabolic diseases	0.893

TABLE D.2 continued

237–Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
056	065	280	Iron deficiency anaemias	0.890
057	066	281	Pernicious anaemia and other deficiency anaemias	0.871
058	067	282-289	Other diseases of blood and blood-forming organs	0.845
059	068	291	Alcoholic psychosis	1.287
060	069	295	Schizophrenia	1.856
061	070	296	Affective psychoses	0.994
062	071	290, 292-294, 297-299	Other psychoses	1.226
063	072	300	Neuroses	0.832
064	073	303	Alcoholism	0.975
065	074	304	Drug dependence	1.787
066	075	301-302, 305-309	Other non-psychotic mental disorders	1.313
067	076	310-315	Mental retardation	2.251
068	077, 008	320-324, 036, 037	Meningitis and other inflammatory diseases of the central nervous system	1.698
069	078, 079	330-332, 333	Hereditary and familial diseases of the nervous system	2.358
070	080	340	Multiple sclerosis	1.324
071	081	342	Paralysis agitans	1.042
072	082	345	Epilepsy	0.815
073	083	346-348	Migraine, other diseases of brain and motor neurone diseases	1.408
074	084	341, 343-344, 349	Other diseases of central nervous system	1.416
075	085	350-358	Diseases of nerves and peripheral ganglia	0.962
076	086	360	Conjunctivitis and ophthalmia	1.266

TABLE D.2 continued

237–Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
077	087	361-369	Inflammatory diseases of the eye	1.611
078	088	373	Strabismus	2.020
079	089	374	Cataract	1.791
080	090	375	Glaucoma	1.882
081	091	370-372, 376-379	Other diseases of the eye	2.140
082	092	381	Otitis media without mention of mastoiditis	1.064
083	093	382-383	Mastoiditis with or without otitis media	1.989
084	094	380, 384-389	Other diseases of ear and mastoid process	1.501
085	095	390-392	Active rheumatic fever	0.940
086	096	393-398	Chronic rheumatic heart disease	2.017
087	097	400-404	Hypertensive disease	0.567
088	098	410	Acute myocardial infarction	0.690
089	099	411-414	Other ischemic heart disease	0.678
090	100	420-429	Other forms of heart disease	0.616
091	101	431	Cerebral hemorrhage	1.017
092	102	432-434	Cerebral embolism and thrombosis	1.091
093	103	430, 435-438	Other cerebrovascular disease	0.632
094	104	440	Arteriosclerosis	0.844
095	105	441	Aortic aneurysm	1.707
096	106	442-448	Other diseases of arteries, arterioles, and capillaries	1.450
097	107	450	Pulmonary embolism and infarction	1.206
098	108	451	Phlebitis and thrombophlebitis	0.651
099	109	452, 453	Venous embolism and thrombosis	1.186
100	110	454	Varicose veins of lower extremities	0.893
101	111	455	Hemorrhoids	0.832
102	112	457	Non-infective disease of lymphatic channels	1.242

TABLE D.2 continued

237–Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
103	113	456, 458	Other diseases of the circulatory system	1.119
104	114	460-466	Acute upper respiratory infection, except influenza	0.641
105	115	470-474	Influenza	0.539
106	116	480-486	Pneumonia	0.522
107	117	490, 491	Bronchitis	0.523
108	118	492	Emphysema	0.664
109	119	493	Asthma	0.764
110	120	500	Hypertrophy of tonsils and adenoids	0.906
111	121	503	Chronic sinusitis	1.340
112	122	504	Deflected nasal septum	1.802
113	123	501, 502, 505-508	Other diseases of upper respiratory tract	1.356
114	124	510, 513	Empyema and abscess of lung	1.570
115	125	515, 516	Pneumoconiosis and related diseases	1.377
116	126	511, 512, 514	Other diseases of respiratory system	0.686
117	127	517-519	Other chronic interstitial pneumonia, bronchiectasis and all other diseases of respiratory system	0.938
118	128	520-525	Diseases of teeth and supporting structures	0.991
119	129	526-529	Other diseases of oral cavity, salivary glands, and jaws	0.928
120	130	530	Diseases of esophagus	1.267
121	131	531	Ulcer of stomach	0.800
122	132	532	Ulcer of duodenum	0.691
123	133	533	Peptic ulcer, site unspecified	0.566
124	134	534	Gastrojejunal ulcer	1.054
125	135	535	Gastritis and duodenitis	0.507

TABLE D.2 continued

237– Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
126	136	536, 537	Other diseases of stomach and duodenum	0.713
127	137	540-543	Appendicitis	0.711
128	138	550, 551	Hernia without mention of obstruction	0.771
129	139	552, 553	Hernia with obstruction	1.001
130	140	560	Intestinal obstruction without mention of hernia	0.762
131	141	561	Gastroenteritis and colitis, except ulcerative, of non-infectious origin	1.214
132	142	563	Chronic enteritis and ulcerative colitis	1.108
133	143	562	Diverticula of intestine	0.706
134	144	564-569	Other diseases of intestines and peritoneum	0.690
135	145	571	Cirrhosis of liver	0.922
136	146	570, 572, 573	Other diseases of liver	1.033
137	147	574	Cholelithiasis	0.782
138	148	575	Cholecystitis and cholangitis, without mention of calculus	0.638
139	149	576	Other diseases of gallbladder and biliary ducts	0.735
140	150	577	Diseases of pancreas	0.931
141	151	580-584	Nephritis and nephrosis	3.378
142	152	590	Infections of kidney	0.617
143	153	591	Hydronephrosis	1.449
144	154	592, 594	Calculus of urinary system	0.988
145	155	595	Cystitis	0.904
146	156	596	Other diseases of bladder	1.475
147	157	598	Stricture of urethra	1.616

TABLE D.2 continued

237–Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
148	158	593, 597, 599	Other diseases of urinary system	1.146
149	159	600	Hyperplasia of prostate	1.243
150	160	605	Redundant prepuce and phimosis	0.982
151	161	601-604, 606-607	Other diseases of male genital organs	0.806
152	162	610, 611	Diseases of breast	0.920
153	163	612-616	Diseases of ovary, fallopian tube, and parametrium	0.942
154	164	620	Infective diseases of cervix uteri	1.005
155	165	622	Infective diseases of uterus (except cervix), vagina, and vulva	0.847
156	166	623	Uterovaginal prolapse	0.998
157	167	624	Malposition of uterus	1.198
158	168	626	Disorders of menstruation	0.867
159	169	621, 625, 627-629	Other diseases of female genital organs	0.902
160	170	630, 635	Infection of genital tract during pregnancy and urinary infections during pregnancy and puerperium	1.068
161	171	632	Hemorrhage of pregnancy	0.699
162	172	631, 633, 634	Other complications of pregnancy	0.860
163	173, 215	636-639, 762	Pre-eclampsia, eclampsia, toxemia-unspecified, and hyperemesis gravidarum; Renal disease and other toxemias of pregnancy and the puerperium	0.886
164	175, 223	640-645, 773	Abortion, termination of pregnancy	1.404
165	176	650	Delivery without mention of complication	0.953

TABLE D.2 continued

237–Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
166	177	651-653	Delivery complicated by: placenta previa or antepartum hemorrhage, retained placenta or other post-partum hemorrhage	1.285
167	178, 179	654, 655	Delivery complicated by bony pelvis Delivery complicated by fetopelvic disproportion	1.704
168	180	656	Delivery complicated by malpresentation of fetus	1.573
169	181	657	Delivery complicated by prolonged labor or other origin	1.417
170	182	658-662	Delivery with other complications including anesthetic; death in uncomplicated delivery	1.377
171	183	670-678	Complications of puerperium	0.916
172	184	684	Impetigo	1.762
173	185	685	Pilonidal cyst	0.998
174	186	680-683, 686	Infections of skin and subcutaneous tissue	0.580
175	187	690-698	Other inflammatory conditions of skin and subcutaneous tissue	0.730
176	188	700-709	Other diseases of skin and subcutaneous tissue	0.801
177	189	712	Rheumatoid arthritis and allied conditions	1.370
178	190	713	Osteoarthritis and allied conditions	1.002
179	191	710, 711, 714-718	Other arthritis and rheumatism	0.530
180	192	720-723	Osteomyelitis and other diseases of bone	1.086
181	193	725	Displacement of intervertebral disc	0.935
182	194	724, 726-729	Other diseases of joint	1.024
183	195	731	Synovitis, bursitis, and tenosynovitis	0.840
184	196	730, 732-738	Other diseases of musculoskeletal system	1.162
185	197	741, 742	Spina bifida and congenital hydrocephalus	3.170

TABLE D.2 continued

237–Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
186	198	743	Other congenital anomalies of nervous system	2.800
187	199	744	Congenital anomalies of eye	2.706
188	200	745.0-745.3	Anomalies of ear	2.022
189	201	746	Congenital anomalies of heart	3.527
190	202	747.0-747.2	Patent ductus arteriosus, coarctation of aorta, and other anomalies of aorta	4.165
191	203	747.3-747.9	Other congenital anomalies of circulatory system	3.459
192	204, 205	748.1, 749.0	Other anomalies of nose, cleft palate	2.969
193	206	749.1	Cleft lip	3.830
194	207	749.2	Cleft palate with cleft lip	3.151
195	208	750, 751	Other congenital anomalies of digestive system	1.624
196	209	752, 753	Congenital anomalies of genito-urinary system	1.460
197	210	754	Clubfoot (congenital)	2.000
198	211	755, 756	Congenital anomalies of musculoskeletal system	2.125
199	212	740, 745.4-745.9 748.0, 748.2-748.6, 748.8, 749.9, 757-759	Other and unspecified congenital anomalies	1.511
200	213, 214, 216	760, 761, 763	Chronic circulatory and genitourinary diseases in mother; maternal ante- and intrapartum infection; other maternal conditions unrelated to pregnancy	1.075
201	217	764.0-764.3, 765.0-765.3, 766.0-766.3, 767.0-767.3, 768.0-768.3, 772.0-772.9	Birth injury	1.999

TABLE D.2 continued

237–Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
202	218	764.4, 765.4, 766.4, 767.4, 768.4, 776	Asphyxia, anoxia, or hypoxia	1.898
203	219, 221	774, 775, 778.2	Hemolytic or hemorrhagic disease of newborn	1.913
204	220	777	Immaturity unspecified (excludes immature newborn)	2.580
205	222	764.9, 765.9, 766.9, 767.9, 768.9, 778.0, 778.1, 778.3, 778.9, 769-771, 779	Other causes of perinatal morbidity and mortality	2.162
206	224	793	Observation, without need for further medical care	1.250
207	225	780-792, 794-796	Symptoms, senility, and ill-defined conditions	0.985
208	226	800, 801	Fracture of skull	1.670
209	227	802.2-802.4	Fracture of jaw	1.225
210	228	802.0, 802.1, 802.5, 802.9, 803, 804	Other fractures of skull and face bones	1.136
211	229	805-809	Fractures of spine and trunk	0.631
212	230	810-819	Fracture of upper limb	0.616
213	231	820-821	Fracture of femur	0.928
214	232	822-829	Other fractures of lower limbs	0.657
215	233	830-848	Dislocation without fracture, sprains of joints and adjacent muscles	0.556
216	234	850, 854	Intracranial injury excluding those with skull fracture	0.718
217	235, 236, 237	851.0, 852.0, 853.0 851.1, 852.1, 853.1, 851.9, 852.9, 853.9	Intracranial injury without mention of open intracranial wound; with open intracranial wound; late effects	1.983

TABLE D.2 continued

237–Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
218	238	860-869	Internal injury of chest, abdomen, and pelvis	0.867
219	239	873, 879.7-879.9	Other and unspecified laceration of head and other multiple and unspecified open wounds of head, neck and trunk without mention of complication, with complication and late effect	0.559
220	240	870-872	Open wound of eye and ear	1.293
221	241	885-887	Traumatic amputation of upper limbs	1.078
222	242	895-897	Traumatic amputation of lower limbs	1.163
223	243	874-879.1, 880-884, 890-894 900-918	Other lacerations and open wound of head, neck and trunk	0.562
224	244	920-929	Contusion and crushing with intact skin surface	0.460
225	245	930-939	Effects of foreign body entering through orifice	1.125
226	246	940-949	Burns	0.733
227	247	950-959	Injury to nerves and spinal cord	1.359
228	248	960-979	Adverse effects of medical agents	0.784
229	249	980-989	Toxic effect of substances chiefly non-medicinal as to source	0.759
230	250	990-996	Other adverse effects	0.536
231	251	997-999	Complications peculiar to certain surgical and medical procedures	0.988
232	254	Y10	Medical and surgical aftercare	1.075
233	255	Y11, Y12	Plastic surgical treatment and fitting of prosthetic device	2.528
234	252, 253, 256, 259	Y00.0-Y00.9, Y01, Y03-Y09, Y13	Medical or special examination, prophylatic inoculation and vaccination, special conditions and examinations without sickness, mature infant not classified as newborn	1.166

TABLE D.2 continued

237–Category code (j)	1969 OBCS	ICDA–8 Codes, 1969	Description	Mean $\overline{H}_j$
235	257	Y20, Y22, Y23, Y26, Y27	Mature newborn	0.941
236	258	Y21, Y24, Y25, Y28, Y29	Immature newborn	1.067
237	260	Y14	Donors for organ transplant surgery	1.262

APPENDIX E

Econometric analysis – preliminary results and methodological details

As noted in Chapter 4, the results reported here begin with estimations of CASEX and DAYEX equations that differ slightly from those specified in Chapter 3. In particular, OCC appears in the CASEX equations in place of ALS, and neither OCC nor ALS appears in the DAYEX equations. In addition, CMPXC1 and SPCLC1 were included rather than CMPXC2 (or CMPXCW), or SPCLC2 or SPCLC3, respectively.

Tables E.1 and E.2 report the results of estimating CASEX and DAYEX equations on the set of variables that survived these early correlation and significance cuts. The procedure was a year-by-year cross-section ordinary least squares estimation. Detailed interpretation of the estimation results is contained in Chapter 4, where the final stage equations are reported. Of the three non-inpatient care variables, only EDRAT suggests evidence of a significant indirect impact in these early results. As noted in Chapter 4 the other two non-inpatient cost variables and SERV were eliminated from later stages of econometric analysis.

The results from re-estimating the two equations using this reduced set of independent variables are shown in Tables E.3 and E.4. The coefficients in these tables formed the initial values for the maximum-likelihood estimation iterations. It is evident from comparing the pairs of results that the elimination of DEPRAT, OUTXPR, and SERV does not change markedly either the explanatory power of the equations or the magnitude or significance of the remaining parameter estimates.

The purpose of this analysis was to generate pooled time-series/cross-section parameter estimates, which could form the basis for the marginal cost estimation process described in Chapter 5. The simplest way of pooling the data would have been to 'stack' the six years and estimate two equations on the 182 times 6 = 1092 observations. However, that procedure will yield efficient parameter estimates only if the standard conditions are assumed to hold; i.e. if $E(\epsilon_i^2) = \sigma^2$

TABLE E.1

OLS estimation 1, dependent variable CASEX

	1969	1970	1971	1972	1973	1974
B/C	7067.6	8473.2	10900.6	8778.1	13698.9	17303.4
	(17.7)	(16.7)	(19.1)	(17.7)	(19.6)	(19.4)
B^2/C	3.841	3.237	2.317	4.511	1.473	2.617
	(9.14)	(6.70)	(4.22)	(5.71)	(1.80)	(2.20)
OCC	224.2	307.5	301.7	334.1	405.0	555.8
	(7.91)	(8.25)	(8.30)	(6.77)	(7.86)	(7.16)
EDRAT	350.4	440.0	420.0	450.6	1094.6	2038.9
	(2.94)	(3.45)	(3.37)	(2.80)	(5.02)	(5.03)
DEPRAT	−193.3	466.8	237.0	−162.0	73.49	596.8
	(1.22)	(1.63)	(0.93)	(0.81)	(0.23)	(1.42)
OUTXPR	48.04	273.4	−20.71	−84.07	239.7	47.99
	(0.31)	(1.57)	(0.13)	(0.45)	(1.28)	(0.19)
WAGE	236.7	205.1	258.2	245.4	340.1	675.0
	(3.65)	(2.54)	(3.21)	(2.53)	(3.42)	(4.32)
SERV	195.6	133.8	35.59	42.24	−254.4	218.8
	(1.67)	(0.96)	(0.27)	(0.25)	(1.35)	(0.73)
CMPXC1	173.5	101.6	211.2	249.8	156.6	160.5
	(2.86)	(1.83)	(3.42)	(3.38)	(2.20)	(1.68)
SPCLC1	11.16	8.426	14.27	17.75	18.35	21.91
	(3.98)	(2.24)	(3.92)	(3.84)	(4.00)	(3.09)
F_1	6.625	9.25	−5.80	16.22	−9.23	−7.66
	(1.77)	(2.15)	(1.15)	(3.16)	(1.55)	(0.85)
F_2	7.581	8.685	5.935	9.636	12.58	15.05
	(2.21)	(2.21)	(1.58)	(2.00)	(2.59)	(2.15)
F^3	0.066	−12.92	7.403	−2.613	3.493	−2.295
	(0.00)	(1.91)	(1.92)	(0.33)	(0.48)	(0.32)
F_4	14.21	17.83	13.69	16.92	16.76	23.30
	(4.27)	(4.40)	(2.70)	(3.40)	(3.41)	(2.70)
F_5	21.64	32.98	15.50	25.82	18.46	3.680
	(4.98)	(6.19)	(3.25)	(4.38)	(3.35)	(0.44)
F_6	−1.652	−0.132	−4.995	3.707	7.887	−7.127
	(0.41)	(0.03)	(1.33)	(0.79)	(1.32)	(0.83)
F_7	−4.253	−15.94	−11.67	−8.29	−2.02	−5.23
	(1.31)	(3.24)	(2.37)	(1.30)	(0.43)	(0.76)
F_8	−4.254	10.25	−0.686	−4.589	−17.40	8.837
	(1.32)	(2.76)	(0.18)	(1.02)	(3.44)	(1.21)
Constant	−672.9	−636.2	−687.8	−630.7	−526.5	−1460.7
$\bar{R}^2$	0.940	0.928	0.941	0.939	0.937	0.926
SEE	41.42	48.18	47.54	58.90	61.06	87.18

NOTE: t-statistics in parentheses

TABLE E.2

OLS estimation 1, dependent variable DAYEX

	1969	1970	1971	1972	1973	1974
B/D	1804.2	2954.0	2819.1	2566.5	3539.6	3466.4
	(3.00)	(4.24)	(3.59)	(2.80)	(3.82)	(2.81)
B^2/D	1.244	0.829	1.381	1.466	1.299	1.867
	(1.97)	(1.11)	(1.80)	(1.62)	(1.33)	(1.64)
EDRAT	25.44	27.95	29.15	32.71	93.81	239.3
	(2.42)	(2.53)	(2.42)	(2.23)	(4.32)	(6.86)
DEPRAT	0.674	–1.033	13.47	–22.20	11.54	15.53
	(0.05)	(0.05)	(0.55)	(1.26)	(0.36)	(0.44)
OUTXPR	9.072	8.585	6.654	11.67	26.14	17.07
	(0.67)	(0.97)	(0.46)	(0.71)	(1.49)	(0.79)
WAGE	26.34	29.62	29.19	37.81	40.67	49.73
	(4.73)	(4.36)	(3.87)	(4.47)	(4.24)	(3.80)
SERV	5.249	6.900	–11.77	–13.38	–23.90	23.49
	(0.52)	(0.59)	(0.93)	(0.88)	(1.32)	(0.94)
CMPXC1	22.09	24.98	27.74	34.44	26.58	16.65
	(4.08)	(5.08)	(4.64)	(5.37)	(4.01)	(2.12)
SPCLC1	0.615	0.389	0.458	1.058	0.723	1.138
	(2.44)	(1.16)	(1.26)	(2.60)	(1.61)	(1.93)
F_1	–0.754	–0.927	–1.213	–1.139	–1.309	–2.178
	(2.40)	(2.47)	(3.06)	(2.46)	(2.51)	(3.33)
F_2	1.201	1.309	1.309	1.637	2.352	2.466
	(4.16)	(4.07)	(3.70)	(3.93)	(5.13)	(4.26)
F_3	–0.973	–1.339	0.180	–0.295	–0.896	–0.071
	(2.42)	(2.36)	(0.50)	(0.43)	(1.22)	(0.12)
F^4	0.661	0.387	–0.586	0.235	0.721	–1.487
	(2.29)	(1.10)	(0.91)	(0.51)	(1.51)	(1.67)
F_5	0.443	0.562	0.587	0.748	1.322	1.547
	(1.18)	(1.23)	(1.24)	(1.44)	(2.41)	(2.12)
F_6	–0.561	–0.225	–0.235	0.359	–0.004	–0.107
	(1.60)	(0.72)	(0.662)	(0.87)	(0.00)	(0.15)
F_7	–0.075	–0.773	–0.545	–0.284	–0.826	–0.760
	(0.26)	(1.88)	(1.13)	(0.53)	(1.86)	(1.33)
F_8	–10.107	0.276	–0.503	–0.290	–1.282	–0.706
	(0.39)	(0.89)	(1.44)	(0.74)	(2.68)	(1.13)
Constant	–22.55	–29.18	–8.698	–15.31	–0.446	–35.54
$\bar{R}^2$	0.706	0.712	0.699	0.712	0.708	0.695
SEE	3.56	4.04	4.47	5.19	5.82	7.32

NOTE: t-statistics in parentheses

TABLE E.3

OLS estimation 2, dependent variable CASEX

	1969	1970	1971	1972	1973	1974
B/C	8279.2	9928.8	10909.5	12501.2	13008.2	16203.3
	(14.5)	(15.2)	(18.2)	(19.0)	(17.7)	(17.8)
B^2/C	2.951	1.920	2.331	2.673	1.963	3.531
	(5.93)	(3.37)	(4.03)	(3.69)	(2.33)	(2.99)
OCC	253.5	313.2	288.1	376.9	386.7	491.1
	(8.72)	(8.73)	(8.64)	(8.98)	(7.87)	(6.64)
EDRAT	306.7	398.0	411.8	353.1	1098.3	2111.6
	(2.69)	(3.22)	(3.36)	(2.59)	(5.17)	(5.45)
WAGE	258.2	214.4	252.7	244.0	328.4	638.0
	(4.12)	(2.74)	(3.16)	(2.94)	(3.33)	(4.23)
CMPXC1	222.9	171.1	217.7	295.2	164.5	170.7
	(3.92)	(3.29)	(3.66)	(4.67)	(2.40)	(1.92)
SPCLC1	11.20	11.17	14.56	15.95	16.64	18.57
	(4.18)	(3.06)	(3.96)	(4.03)	(3.59)	(2.67)
F_1	-1.547	0.982	-5.61	-11.54	-2.37	4.56
	(0.34)	(0.20)	(1.02)	(2.00)	(0.35)	(0.50)
F_2	5.50	7.26	6.07	8.55	13.70	17.94
	(1.66)	(1.88)	(1.60)	(2.07)	(2.83)	(2.63)
F_3	4.975	-2.673	7.43	14.15	-1.703	0.789
	(0.95)	(0.37)	(1.93)	(2.01)	(0.21)	(0.11)
F_4	12.29	15.12	11.26	6.18	16.48	-0.005
	(3.97)	(3.78)	(1.61)	(1.40)	(3.44)	(0.00)
F_5	15.72	22.00	15.36	18.20	20.78	11.59
	(3.38)	(4.00)	(3.05)	(3.63)	(3.66)	(1.39)
F_6	-2.711	-2.324	-5.548	4.269	4.099	-2.246
	(0.57)	(0.64)	(1.51)	(1.07)	(0.66)	(0.27)
F_7	-1.136	-12.55	-10.67	-6.01	-1.65	-3.61
	(0.35)	(2.69)	(2.12)	(1.11)	(0.36)	(0.54)
F_8	-2.44	6.35	-0.77	-4.89	-17.82	-0.79
	(0.80)	(1.72)	(0.20)	(1.27)	(3.56)	(0.11)
Constant	-607.9	-577.7	-632.9	-775.4	-719.1	-1107.8
$\bar{R}^2$	0.927	0.910	0.924	0.926	0.909	0.909
SEE	40.55	47.10	47.38	50.75	60.54	84.49

NOTE: t-statistics in parentheses

and $E(\epsilon_i\epsilon_j) = 0$; $i,j = 1, \ldots, 1092$; $i \neq j$. In particular, this would require $E(\epsilon_{it}, \epsilon_{i,t+i}) = 0$, etc. Equivalently, if we denote $E(\epsilon\epsilon')$ by Ω, then those conditions would be expressed by:

$$\Omega = \sigma^2 I, \text{ where } I \text{ is a } 1092 \times 1092 \text{ identity matrix.}$$

In short, the adoption of that estimation technique would require us to assume that there is no relationship between the residuals in year t and those in

TABLE E.4

OLS estimation 2, dependent variable DAYEX

	1969	1970	1971	1972	1973	1974
B/D	1811.1	2963.1	2951.2	2384.0	3709.0	3728.6
	(3.12)	(4.57)	(4.24)	(2.67)	(4.29)	(3.12)
B^2/D	1.143	0.754	1.408	1.549	1.260	1.723
	(1.85)	(1.03)	(1.86)	(1.72)	(1.30)	(1.53)
EDRAT	23.77	26.81	28.51	33.57	90.56	235.4
	(2.32)	(2.46)	(2.42)	(2.34)	(4.24)	(6.85)
WAGE	26.59	30.11	29.16	38.90	41.31	49.45
	(4.86)	(4.51)	(3.90)	(4.57)	(4.34)	(3.81)
CMPXC 1	23.82	26.05	27.79	33.48	27.40	19.62
	(4.75)	(5.68)	(4.86)	(5.31)	(4.27)	(2.65)
SPCLC 1	0.602	0.395	0.456	1.006	0.715	1.226
	(2.45)	(1.20)	(1.27)	(2.48)	(1.59)	(2.11)
F_1	−0.739	−0.911	−1.212	−1.142	−1.318	−2.065
	(2.37)	(6.06)	(3.08)	(2.47)	(2.54)	(3.22)
F_2	1.180	1.319	1.329	1.611	2.384	2.527
	(4.20)	(4.13)	(3.78)	(3.89)	(5.24)	(4.41)
F_3	−0.977	−1.337	0.149	−0.088	−0.719	−0.166
	(2.48)	(2.44)	(0.42)	(0.13)	(1.02)	(0.28)
F_4	0.665	0.354	−0.583	0.089	0.612	−1.470
	(2.34)	(1.02)	(0.93)	(0.19)	(1.30)	(1.73)
F_5	0.385	0.510	0.543	0.701	1.143	1.328
	(1.07)	(1.15)	(1.39)	(1.39)	(2.14)	(1.90)
F_6	−0.517	−0.245	−0.216	0.317	−0.088	0.072
	(1.56)	(0.79)	(0.63)	(0.78)	(0.15)	(0.10)
F_7	−0.033	−0.677	−0.552	−0.340	−0.824	−0.703
	(0.12)	(1.73)	(1.18)	(0.65)	(1.86)	(1.24)
F_8	−0.087	0.250	−0.506	−0.259	−1.232	−0.559
	(0.33)	(0.82)	(1.46)	(0.66)	(2.59)	(0.94)
Constant	−18.45	−23.12	−19.83	−28.38	−23.54	−13.34
$\overline{R}^2$	0.710	0.715	0.702	0.711	0.708	0.696
SEE	3.54	4.01	4.44	5.19	5.82	7.30

NOTE: t-statistics in parentheses

any other year, i.e. no autocorrelation. Yet it seems not unreasonable to think that a hospital with a large error (residual) term in one year would have residuals of similar magnitude, or at least of similar sign, in the following years. Any 'outlying' hospital (in the sense of a large positive or negative residual) is in that position for some reason not captured within our functional form. Many hospitals in such a position will be unable or unwilling to change their mode of operation in the very short term, or, what is more likely, will be unaware of their relative position and therefore will have no reason to attempt to rectify it.

TABLE E.5

Residual correlation matrix: maximum likelihood estimation 1 of CASEXD equation

	1969	1970	1971	1972	1973	1974
1969	1.000	0.892	0.905	0.874	0.779	0.783
1970		1.000	0.950	0.906	0.867	0.841
1971			1.000	0.927	0.860	0.828
1972				1.000	0.929	0.892
1973					1.000	0.950
1974						1.000

To both test and adjust for inter-year residual correlation, a six-equation model (one per year) was estimated using maximum likelihood estimation. The equations were not identical. The factor scores are derived from slightly different proportions of the total variance in the age-sex category variables so that, strictly speaking, F_1 through F_8 are different variables in each year. The maximum likelihood estimation adjusts for cross-equation covariance among the disturbance terms and provides asymptotically efficient, consistent estimators (see e.g. Kmenta 1971, 578-81). It also provides information about the nature of any autoregressive pattern. In effect, the procedure assumes that Ω takes the flexible form

$$\Omega = \delta^2 \mathrm{I} \begin{bmatrix} 1 & \rho_{12} & \rho_{16} \\ \rho_{21} & 1 & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \rho_{61} & & 1 \end{bmatrix}$$ (ρ_{ij} is the correlation of the residuals in years i and j)

(so that we allow for any and all cross-equation residual interactions) and provides estimates of the population (ρ_{ij}) values.

As noted in the text, CASEXD, DAYEXD, and CMPADJ were substituted for their cross-section counterparts at this stage. The residual correlation matrices from the maximum likelihood estimation of the CASEXD and DAYEXD equations are reproduced as Tables E.5 and E.6. It is immediately evident that this sample of hospitals does not support the normal assumption of non-autocorrelation inherent in the OLS estimation procedure. In fact, some crude calculations based on Table E.5 suggest a first-order autoregressive pattern in the residuals, with $\rho \simeq 0.945$. The average correlation of residuals separated by one year

TABLE E.6

Residual correlation matrix: maximum likelihood estimation 1 of DAYEXD equation

	1969	1970	1971	1972	1973	1974
1969	1.000	0.888	0.835	0.748	0.717	0.673
1970		1.000	0.915	0.806	0.789	0.718
1971			1.000	0.907	0.859	0.796
1972				1.000	0.904	0.829
1973					1.000	0.909
1974						1.000

$$\sum_{i=1}^{5} \rho_{i,\,i+1}/5$$

is equal to 0.930. Similarly,

$$\sum_{i=1}^{4} \rho_{i,\,i+2}/4 = 0.891$$

from which we note that $(0.891)^{1/2} = 0.944$. Denoting the average correlation by $\bar{\rho}_T$, where τ refers to the time span, similar calculations yield the following results:

$$\begin{array}{ll} \bar{\rho}_3 = 0.856 & (\bar{\rho}_3)^{1/3} = 0.950 \\ \bar{\rho}_4 = 0.810 & (\bar{\rho}_4)^{1/4} = 0.949 \\ \bar{\rho}_5 = 0.783 & (\bar{\rho}_5)^{1/5} = 0.952 \\ \hline & \text{average } (\bar{\rho}_T)^{1/T} = 0.945 \end{array}$$

A similar set of calculations for the residual correlations of Table E.6 suggests a comparable first order autoregressive approximation, with $\rho \simeq 0.916$. While it is interesting to observe that the strength of residual correlations 'decays' in the first-order manner, the most important information contained in these two tables is the strong evidence refuting the normal $E(\epsilon_i, \epsilon_j) = 0$ assumption.

Having established the illegitimacy of using pooled OLS regressions to provide efficient, unbiased parameter estimates, we focus now on the maximum-likelihood estimates reported in Tables 9 and 10 in Chapter 4 (which are reproduced here as Tables E.7 and E.8). These coefficients are, as noted above, the results of estimating six-equation systems and adjusting for autocorrelation. There are some striking differences in the estimates reported in these tables and in the second set of OLS results. One expected trend would be for the MLE coefficients to show considerably more stability than their OLS counterparts

TABLE E.7

Maximum likelihood estimation 1, dependent variable CASEXD

	1969	1970	1971	1972	1973	1974
B/C	4387.3	4053.2	4159.1	4460.0	4041.0	5150.4
	(10.9)	(10.5)	(11.4)	(11.4)	(8.92)	(11.7)
B^2/C	4.065	3.612	3.830	3.832	3.650	3.829
	(10.6)	(8.70)	(9.32)	(7.84)	(6.40)	(6.01)
OCC	100.8	91.24	104.5	126.8	132.4	159.2
	(5.05)	(4.43)	(6.07)	(6.36)	(5.73)	(6.04)
EDRAT	177.0	162.6	147.5	28.23	140.9	508.8
	(1.97)	(1.90)	(1.83)	(0.38)	(1.43)	(3.57)
WAGE	197.5	144.6	152.2	166.9	135.5	243.5
	(5.03)	(3.59)	(4.00)	(4.54)	(3.30)	(4.76)
CMPADJ	92.37	59.60	74.17	127.3	33.74	-32.80
	(2.15)	(1.78)	(2.16)	(3.74)	(0.99)	(0.91)
SPCLC1	17.20	18.96	19.10	21.11	19.68	26.83
	(7.44)	(6.70)	(7.15)	(7.45)	(5.70)	(6.42)
F_1	14.06	17.04	19.44	16.37	15.56	20.29
	(4.18)	(5.24)	(5.73)	(4.92)	(4.13)	(4.62)
F_2	-8.441	-10.41	-8.336	-8.349	-7.254	-9.018
	(2.73)	(3.27)	(2.87)	(2.76)	(2.04)	(2.22)
F_3	15.64	9.536	-1.012	16.29	15.29	-9.415
	(4.58)	(2.60)	(0.45)	(5.34)	(4.17)	(3.17)
F_4	1.359	-0.339	13.94	-6.522	-2.359	12.74
	(0.56)	(0.13)	(4.58)	(3.02)	(0.93)	(3.23)
F_5	11.29	12.58	11.68	9.677	10.45	0.196
	(3.78)	(4.38)	(4.94)	(4.24)	(3.96)	(0.06)
F_6	-3.845	0.072	0.351	-3.229	7.297	-3.223
	(1.75)	(0.04)	(0.22)	(1.82)	(3.25)	(1.14)
F_7	3.364	-5.233	-7.764	-5.553	-2.446	-1.056
	(1.78)	(2.33)	(3.79)	(2.77)	(1.33)	(0.54)
F_8	0.785	2.887	-1.199	0.560	0.706	1.494
	(0.48)	(1.72)	(0.82)	(0.43)	(0.40)	(0.62)
Constant	-170.5	-69.29	-102.1	-184.4	-59.59	-162.7
$\bar{R}^2$	0.858	0.800	0.826	0.818	0.756	0.792
SEE	54.12	62.09	58.88	60.80	69.53	75.10

NOTE: t-statistics in parentheses

because the MLE dependent variables were deflated values and thus themselves much more stable, as illustrated in Table 7. This difference is most vividly illustrated by the contrasting patterns of the B/C and WAGE parameter estimates in Tables E.3 and 9 (E.7) respectively. What is just as striking but without an obvious explanation is the emergence of F_1 as a strongly significant variable and the reversal of direction of impact of F_2 in the MLE results. In fact with the

TABLE E.8

Maximum likelihood estimation 1, dependent variable DAYEXD

	1969	1970	1971	1972	1973	1974
B/D	2324.3	2815.3	2398.9	1414.3	1744.5	1020.5
	(7.65)	(11.5)	(10.8)	(5.31)	(7.44)	(3.00)
B^2/D	1.991	2.040	2.293	2.343	2.620	2.543
	(4.56)	(4.55)	(5.83)	(5.12)	(5.55)	(5.15)
EDRAT	8.216	12.02	10.34	0.353	5.590	44.60
	(1.05)	(1.68)	(1.66)	(0.05)	(0.65)	(3.48)
WAGE	27.76	26.25	27.49	28.25	27.18	19.87
	(8.08)	(7.91)	(9.04)	(8.03)	(7.89)	(4.48)
CMPADJ	16.32	13.88	14.23	20.64	16.33	12.64
	(4.39)	(4.92)	(5.07)	(6.70)	(5.84)	(4.31)
SPCLC1	0.770	0.868	0.786	1.045	0.772	1.061
	(4.18)	(4.10)	(3.93)	(4.64)	(3.07)	(3.65)
F_1	–0.447	–0.398	–0.233	–0.234	–0.439	–0.558
	(1.94)	(1.70)	(1.02)	(0.92)	(1.65)	(1.76)
F_2	0.173	0.232	0.215	0.227	0.611	0.449
	(0.70)	(0.95)	(0.93)	(0.87)	(2.17)	(1.44)
F_3	0.000	–0.254	0.004	0.465	0.345	0.043
	(0.00)	(0.95)	(0.03)	(1.75)	(1.22)	(0.18)
F_4	0.131	–0.127	0.198	–0.198	0.126	–0.072
	(0.69)	(0.68)	(0.84)	(1.05)	(0.65)	(0.23)
F_5	0.171	0.036	0.082	0.170	0.279	0.265
	(0.74)	(0.17)	(0.44)	(0.81)	(1.30)	(0.96)
F_6	–0.297	–0.313	–0.259	0.135	0.051	0.090
	(1.62)	(2.17)	(1.99)	(0.82)	(0.27)	(0.39)
F_7	0.044	–0.272	–0.035	0.022	–0.083	0.001
	(0.28)	(1.66)	(0.23)	(0.12)	(0.54)	(0.00)
F_8	–0.114	–0.152	–0.029	0.027	–0.032	0.071
	(0.87)	(1.27)	(0.28)	(0.22)	(0.23)	(0.37)
Constant	–13.67	–11.42	–10.65	–12.65	–7.608	5.538
$\bar{R}^2$	0.643	0.634	0.634	0.649	0.605	0.593
SEE	3.77	4.03	4.05	4.39	4.76	4.98

NOTE: t-statistics in parentheses

exception of F_5, all the factor scores exhibit markedly different patterns in the CASEX and CASEXD results. The factor scores seem generally less important in both DAYEX runs. Since these MLE parameter estimates represent the asymptotically efficient estimates and form the basis of the analysis in Chapter 5, they are reported and interpreted in the text.

APPENDIX F

Estimated marginal case costs for 188-category Canadian hospital morbidity list

APPENDIX F: Estimated marginal case costs for 188-category Canadian hospital morbidity list

188-Category number	237-Category equivalents	MCC1 ($1969)	MCC2 ($1969)	188-Category number	237-Category equivalents	MCC1 ($1969)	MCC2 ($1969)
1	001	420.37	626.20	25	031	430.36	701.33
2	002-003	268.91	345.24	26	033	423.60	644.58
3	004	447.80	771.58	27	032, 034	480.03	769.73
4	006	306.22	377.38	28	035	568.70	992.91
5	009	364.58	477.36	29	036	449.00	733.16
6	011	364.14	557.75	30	037	439.86	652.62
7	013	346.14	521.58	31	038	487.83	699.77
8	008, 010, 012, 009(0.9)	279.81	367.00	32	040	283.95	343.08
9	014	310.67	402.75	33	039	275.06	315.70
10	005, 007, 015-016	348.14	506.12	34	041	326.35	430.09
11	017	514.88	774.69	35	042	317.54	422.90
12	018	454.86	763.05	36	043	271.80	328.89
13	019	480.25	824.42	37	044	425.63	701.93
14	020	496.70	841.50	38	045	301.12	401.98
15	021	470.99	799.72	39	046	346.48	452.62
16	022*	461.43	752.94	40	047	347.33	497.94
17	023	507.96	801.38	41	049	335.46	455.71
18	024	505.78	823.91	42	048	398.63	597.36
19	025	395.77	563.54	43	050	359.28	544.02
20	026	428.31	648.48	44	051	347.14	537.05
21	027	514.82	701.87	45	052	379.45	569.21
22	028	432.70	618.38	46	053	348.18	526.18
23	029	473.78	696.03	47	054	466.87	733.37
24	030, 028(0.05)	507.45	804.59	48	055	351.87	552.69

* Although no. 16 includes 'malignant neoplasm of trachea,' which is part of our code 023, it is a small part. In 1974 for example, there were twenty-one such cases in Ontario, while category 023 also contained 939 other separations that did not belong in list no. 16.

APPENDIX F continued

188-Category number	237-Category equivalents	MCC1 ($1969)	MCC2 ($1969)	188-Category number	237-Category equivalents	MCC1 ($1969)	MCC2 ($1969)
49	056	346.48	528.33	74	083	376.01	489.74
50	057	383.63	609.51	75	084	333.46	406.04
51	058	299.25	416.27	76	085	362.23	587.18
52	059	378.36	568.20	77	086	477.71	775.68
53	060	540.54	929.48	78	087	317.80	474.38
54	061	426.16	720.12	79	088	408.39	651.07
55	062	447.59	770.22	80	089	363.09	552.04
56	063	365.82	577.42	81	090	352.15	540.79
57	064	320.49	438.34	82	091	369.76	596.66
58	065	386.28	555.38	83	092	448.51	753.33
59	066	387.75	591.87	84	093	412.19	674.71
60	067	435.15	639.27	85	094	419.08	688.70
61	068	413.58	665.71	86	095, 096	474.09	796.15
62	069	468.66	758.48	87	097	431.18	681.60
63	070	470.42	807.41	88	098, 099	357.29	549.58
64	071	470.04	825.62	89	100	321.62	434.54
65	072	303.82	437.94	90	101	302.08	393.70
66	073, 074	420.78	705.20	91	102, 103	356.74	524.23
67	075	332.76	484.72	92	104	259.09	322.78
68	076, 077	345.59	458.39	93	105	260.21	331.65
69	078	335.28	370.99	94	106	299.83	431.28
70	079	400.35	532.71	95	107, 108	292.61	413.63
71	080	392.48	532.59	96	109	287.80	388.03
72	081	401.21	524.85	97	110	243.31	265.81
73	082	282.83	341.37	98	111	311.27	386.47

APPENDIX F continued

188-Category number	237-Category equivalents	MCC1 ($1969)	MCC2 ($1969)	188-Category number	237-Category equivalents	MCC1 ($1969)	MCC2 ($1969)
99	112	343.07	397.36	126	143, 146-148	347.92	475.82
100	113	311.52	379.56	127	149	409.19	622.76
101	114	456.00	799.02	128	150	254.83	287.00
102	115	379.63	590.64	129	151	282.57	364.53
103	116, 117	349.62	525.67	130	152	269.96	322.19
104	118	246.31	267.23	131	153	315.26	414.95
105	119	275.28	352.88	132	154, 155	283.34	343.01
106	122	346.47	513.70	133	156, 157	356.69	500.06
107	121, 123	352.39	535.06	134	158	269.67	319.18
108	125	262.77	342.28	135	159	287.25	354.77
109	120, 124, 126	335.61	490.81	136	160	289.02	356.65
110	127	280.09	360.29	137	161	262.39	320.60
111	128	298.70	395.95	138	163	288.95	363.58
112	129	325.60	449.36	139	162	257.47	294.29
113	130	343.72	517.30	140	164	308.26	350.32
114	132	412.91	674.31	141	165	295.91	366.66
115	131, 133, 134	318.90	457.79	142	166	354.54	474.64
116	135	422.94	683.26	143	167, 168, 169	374.60	485.86
117	136	375.31	596.88	144	170	359.96	469.05
118	137	345.97	493.05	145	171	259.53	304.04
119	138	319.15	454.25	146	172, 173, 174	290.88	393.21
120	139	336.05	508.95	147	175	320.23	489.02
121	140	360.49	544.96	148	176	299.88	417.40
122	141	465.67	519.52	149	177	472.19	821.64
123	142	293.64	419.34	150	178	415.16	697.83
124	144	321.60	433.19	151	179	314.16	477.16
125	145	289.66	377.08	152	180	394.19	637.83

APPENDIX F continued

188-Category number	237-Category equivalents	MCC1 ($1969)	MCC2 ($1969)	188-Category number	237-Category equivalents	MCC1 ($1969)	MCC2 ($1969)
153	181	386.90	599.92	171	208-210, 216-217	282.85	369.44
154	182	324.68	442.46	172	211	384.21	624.28
155	183	266.03	325.76	173	212	259.54	330.97
156	184	338.30	475.70	174	213	552.93	995.17
157	185	599.84	1062.55	175	214	338.08	496.25
158	189, 190	529.30	784.29	176	215	270.80	367.95
159	193, 194, 192(0.8)	463.45	629.22	177	218	344.60	514.65
160	195	380.14	579.05	178	219-224	249.65	315.86
161	196	343.14	463.65	179	225	265.99	314.14
162	197, 198	412.54	596.10	180	226	362.47	589.14
163	186-188, 191, 199, 192(0.2)	373.45	510.82	181	227	352.57	533.61
164	201	382.55	490.09	182	228	271.04	339.00
165	202	427.22	628.23	183	229	236.02	282.82
166	203	393.81	520.69	184	231	324.80	462.89
167	204	490.68	746.27	185	230	266.07	362.61
168*	200, 205, 203(0.1)	418.06	532.44	186	232-234, 237	292.13	342.63
169	206	274.48	334.15	187	235	293.88	363.69
170	207	292.78	366.26	188	236	410.87	606.96

* Although Ontario Broad Codes 215 & 223 are included in no. 168, their incidence is so small (five cases of 215, a single case of 223 in 1974) that our codes 163 and 164 (see Table D.2) were not included in this equivalence list.

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